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ABSTRACT

This articulation guide contains 21 units of instruction for two years of machine shop. The objectives of the program are to provide the student with the basic terminology and fundamental knowledge and skills in machining (year 1) and to teach him/her to set up and operate machine tools and make or repair metal parts, tools, and machines (year 2). Introductory materials include recommended secondary and postsecondary programs. The nine units in year 1 are entitled introduction, precision measuring instruments, work layout, benchwork, grinding, drill press, power saws, basic engine lathe work, and mill work. The twelve units in year 2 are entitled advanced blueprint reading, turret lathe, surface grinder, shaper, tool and cutter grinder, heat treatment, hydraulic press, computer numerically controlled machining, machining math calculations, machine shop projects, oxyacetylene cutting/welding and brazing, and shielded metal arc welding. Each unit contains a unit overview, prerequisites, standards, suggested instruction times, and tasks. A task sheet for each task details the performance objective, performance actions, performance standards, suggested instruction time, resources, and related technical information. Additional references include matrixes of occupational competencies, suggested job skills, and a list of equipment. Sample outcome-referenced and performance tests are provided for most units. Appendixes include sample articulation agreements, and test directions. (YLB)

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ARTICULATED, PERFORMANCE-BASED INSTRUCTION OBJECTIVES GUIDE
FOR
MACHINE SHOP/TECHNOLOGY

DEVELOPMENT PERIOD
JULY, 1983 - JUNE, 1984

PREPARED BY
OCCUPATIONAL EDUCATION ARTICULATION PROGRAM
TASK FORCE COMMITTEE
FOR
MACHINE SHOP/TECHNOLOGY
REPRESENTING
THE SCHOOL DISTRICT OF GREENVILLE COUNTY
AND
GREENVILLE TECHNICAL COLLEGE
GREENVILLE, SOUTH CAROLINA

PUBLICATION OF
OCCUPATIONAL EDUCATION ARTICULATION PROGRAM
OF THE SCHOOL DISTRICT OF GREENVILLE COUNTY
AND GREENVILLE TECHNICAL COLLEGE

JUNE, 1984
EDITION I

CE 040 233

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ARTICULATED, PERFORMANCE-BASED CURRICULUM GUIDE

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ARTICULATION GUIDE

THE SCHOOL DISTRICT OF GREENVILLE COUNTY AND GREENVILLE TECHNICAL COLLEGE

THE SCHOOL DISTRICT OF GREENVILLE COUNTY
GREENVILLE, SOUTH CAROLINA

1984

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ACKNOWLEDGEMENT

The Articulated, Performance-based Instruction Objectives Guide for Machine Shop is the product of the work of the following instructor Task Force Committee participants representing the secondary programs of The School District of Greenville County and the post-secondary similar program at Greenville Technical College.

Donaldson Career Center	Melvin J. Nestich
Enoree Career Center	Randy McWhorter
Foothills Career Center	George Caldwell
Greenville Technical College	Charlie Granger

The cooperation of the instructor participants and others representing The School District of Greenville County, Greenville Technical College, and South Carolina State Department of Education, the South Carolina State Board for Technical and Comprehensive Education, and local industries is appreciated.

Typist . . . . Theresa Eubanks
Program Secretary

ABSTRACT

Title of Program: Occupational Education Articulation Program

Program Coordinator: Wm. Edward Henderson Jr.

Sponsoring Agencies: The School District of Greenville County
and Greenville Technical College
c/o P.O. Box 2848 - 301 Camperdown Way
Greenville, SC 29602

Program Development Period: July 1, 1983 through June 30, 1984

PURPOSE: To develop a continuous line of vocational training in similar Machine Shop programs so that students may continue their career/vocational education at the secondary and post-secondary levels without loss of time or waste of effort in repeating tasks that have been mastered previously.

To provide a system where teachers can cooperate effectively in providing a continuous occupational development program where the level and type of training that leads to entry-level employment skills will be clear to students, teachers, other educators, and potential employers.

METHOD: Machine Shop instructor representatives from the three secondary level career centers of The School District of Greenville County and the post-secondary level Machine Technology Department Head from Greenville Technical College were brought together in task force committee meetings and workshops to survey very similar areas of vocational training to identify possible overlaps or gaps as students continue machine shop training from the secondary level to the post-secondary level. In addition, lateral articulation of machine shop programs at the secondary level was promoted.

This Articulated, Performance-based Instruction Objectives Guide for Machine Shop, was developed by the Task Force Committee on Machine Shop to facilitate articulation. The Task Force Committee, by the task analysis process, identified the minimum essential competencies for the secondary machine shop graduate to continue training at the next higher level of education or for successful

initial entry into the labor market in the trade. Major objectives for competency were stated, performance to obtain the objectives were clarified, enabling actions were identified and placed in sequential order, instruction time was estimated, and performance standards were stated. Finally, outcome-referenced (criterion-referenced) measures of performance were developed as a guide in articulating (articulation).

RESULTS:

As a result of the project development phase, the Articulated, Performance-based Instruction Objectives Guide for Machine Shop was developed. This articulation guide, however, is not a final product since it must be field trial tested and revised. Modifications and improvements to the guide are expected since the process of education must be continually reviewed to ensure that objectives are valid and are being met as best they can be met under given conditions.

Prior to development of this articulation guide, an Articulation Policies and Procedures Guide was developed to aid articulation activities and was used to direct program and product (guide) development activities.

Workshop guides, developed and refined during an earlier phase of the program, were used to assist task force committee participants in obtaining task analysis data, writing performance-based objectives, identifying performance actions to reach the objectives, stating performance standards, and developing outcome-referenced tests. These how-to-do-it guides are usable at the instructional level as well as at the supervisory level.

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PREFACE

This Articulated, Performance-based Instruction Objectives Guide is based on the following ASSUMPTIONS:

1. The grouping of tasks is more conducive to skill development in vocational education.

2. Potential employers probably would prefer an employee well educated in the basics with more detailed on-the-job training provided by the employer.

3. Among topics that should be included in vocational education are; safety, career opportunities, how to get and keep a job, and the job attitudes that often are the key to employee success and job retention.

4. A premise of the articulated, performance-based instruction guide is that it is absolutely essential that career/vocational education/training be based on the knowledges, skills, abilities, and personal characteristics that are important to success on the job, if the vocational program is going to validly serve the needs of students and potential employers of the community.

5. Another premise in the articulated instruction guide is that vocational education can no longer be developed according to program titles, be time-based, lack flexibility, or overlook basic fundamentals if instruction is to meet the needs of students and employers and be of the highest quality.

6. Substantial research clearly indicates that instructional technology and accountability demands are increasing the movement toward the use of instructional systems.

   The systems approach, a method of organizing the instructional situation, methods, media, materials, and equipment so that the maximum knowledge and skill development may be achieved, is promoted because it directs its attention toward teaching the observable behaviors that the vocational student should possess at the termination of instruction.

   The instructional program described in this articulated, performance-based instructional objectives guide has been assembled by instructor task force committee participants representing The School District of Greenville County and Greenville Technical College and it is based on the concept that the minimum tasks described should be those identified for successful entry level employment according to local task analysis information, state-of-the-art literature, similar/related research/ publications, and the expertise of the instructor participants.

7. The articulated instruction guide illustrates one way the (secondary) curriculum may be organized. The example is not intended to imply that there are not other ways to structure the curriculum.

   The articulated instruction guide should be preceived as a vehicle to facilitate the development of alternate, detailed instructional plans for the individual learner.

8. While the objectives in this guide typically have been arranged in a sequence from less to more difficult in performance or as they might occur on the job, the sequence of tasks is not meant to indicate a required pattern.

9. The "suggested minimum instruction times" are included for planning purposes and may be extended as required for the completion of task objectives. An underlying premise of the articulated instruction guide is that it is more desirable for the student to complete some objectives and gain some employable skills rather than to be introduced to a large number of tasks and not acquire any employable skills.

   The actual amount of time required for each task objective may vary according to the local program objectives, the individual needs of the learner, the instructor's experiences, and the training facilities and materials available.

10. While it may become necessary to modify the vocational program from the articulated guide description, a lowering of the minimum standards (competency level) recommended by industry should be avoided to ensure that the program graduate can demonstrate a minimum performance essential to employment success.

11. This articulation guide was drafted in a period of less than twelve months so that a product production deadline of twelve months might be met.

    Because of a restricted development time frame, emphasis was placed on developing a sound and valid articulation guide which might be refined at a later date.

Greenville, SC

W.E.H.

PREVIOUS ARTICULATION
(Revised)

A 1975-1976 program of articulation between Greenville Technical College and The School District of Greenville County articulated the similar post-secondary Machine Tool Technology with the similar Machine Shop programs at the secondary level by specifying post-secondary program topics and standards in outline form.

The 1983-1984 Machine Shop/Machine Tool Technology articulation program development activities have revived and strengthened upon the previously established 1976 agreement. (See Appendix A)

As part of the 1976 articulation agreement, Greenville Technical College established a "tuition scholarship" in the Machine Tool Technology program to be awarded to the most outstanding or worthy student from each of the four secondary Machine Shop Programs of The School District of Greenville County. Initially, the tuition scholarship will be for one quarter of tuition free study. Upon successfully completing the first quarter, the scholarship may be extended based upon review and approval by the Machine Tool Technology instructor and Department Head.

According to the 1976 agreements, a graduate of a secondary Machine Shop program of The School District of Greenville County may be granted exemption of a Machine Tool Technology course at Greenville Technical College according to; the recommendations of the former secondary instructor, the student's secondary level performance as represented by grade achievement and a "Proficiency Report," and the individual's performance on "Placement Tests" administered by the Machine Tool Technology Department, GTC. The procedures established in 1976 will be continued, with slight modifications, in the current articulation program.

Every effort has been made to incorporate all previous articulation efforts between the secondary Machine Shop programs and GTC's Machine Tool Technology program and to ensure that provisions are established and documented to encourage the fulfillment and continuation of 1983-1984 articulation agreements.

"Machine Tool Technology Articulation" (Appendix D), Occupational Education Program Articulation Between Secondary Vocational Education Centers and Greenville Technical College, Greenville, SC: Greenville Technical College, 1976. (Included as Appendix A in this Articulated, Performance-based Instruction Guide.

MACHINE SHOP

LEVEL: Secondary

TITLE: Machine Shop I

DESIGNATION: MACHINE SHOP I COMPUTER NUMBER: 759

DESCRIPTION: The introductory year of Machine Shop includes a study of shop safety, shop operations, and career opportunities for machinists. Student machinists learn the working properties of a variety of metals such as steel, cast iron, aluminum, brass, and other materials used to make parts for machines. The student learns how to read blueprints and specifications to determine the dimensions of work and machining computations.

The student will learn to select and use semi-precision and precision measuring instruments such as the micrometer, verniers, gageblocks, various gages, rulers, dial indicators, and calipers. The student will learn to use introductory drafting skills such as the alphabet of lines, tolerances, one-view and multi-view drawings, auxilliary and section views, and freehand drawing.

The machinist student will apply math skills involving the addition, subtraction, multiplication, and division of fractions and decimals as well as taper (per inch) calculations, speeds and feeds formulae and some elementary trigonometry. The student will learn to plan and layout work using the surface plate, surface gage, layout dye, tri square, scribers, dividers, calipers, V-blocks, and angle plates in layouts.

The student will be introduced to benchwork focusing on building machinist's skills in the use of vises, taps, dies, files, hammers, wrenches, hacksaws, the arbor press, and other hand operated tools.

The student will learn the use and care of grinders; the drill presses; vertical and horizontal bandsaws; the milling machine; as well as the engine lathe for grinding, turning, facing, knurling, grooving, boring, taper turning, threading, and drilling.

OBJECTIVE: Machine Shop I is designed to provide the student with the basic terminology as well as fundamental knowledges and skills in machining. Upon completing the first year of training, the machine shop student will be able to employ mathematics to solve machine shop situations; interpret specifications, blueprints, and technical information; identify, use, and maintain hand tools; use and maintain machine shop equipment; layout machining work; and complete basic machining jobs using a variety of machines or hand tools.

The student who has successfully completed Machine Shop I will be prepared for continued study in Machine Shop II. Upon mastering the competencies of the first year of Machine Shop, the student may be qualified to enter employment as a machine operator.

PROFICIENCY EVALUATION: Machine Shop I competencies will be measured by written outcome-referenced transfer and performance tests using the minimum standards recommended by industry for entry level worker success.

Upon successfully completing the first year of secondary machine shop training, the student should be prepared to: read and use all standard measuring instruments associated with the machine shop; perform basic set-ups on lathes, mills, grinders, and drill presses including squaring, turning, and laying out work; process jobs to their completion; and demonstrate safety practices and good work habits important in machining work.

Upon completing Machine Shop I, the student should be able to perform the following:

- Turn outside diameters to shoulder and to +/- .001 inch tolerances
- Mount work between centers, and use collets and chucks
- Read micrometers and vernier scales
- Grind tool bits and sharpening drill bits to proper angles
- Mill square and parallel to +/- .005 inch and do simple indexing on dividing head
- Contour saw stock to layout lines and cut off to length
- Drill, tap, and ream holes to industrial tolerances
- Cut threads, turn tapers, and bore holes to +/- .005 inch tolerance

PREREQUISITES: None

Suggested Entry Grade Level: 11

RECOMMENDED SECONDARY PREPARATION: Secondary level programs which might contribute to the optimum success of the machine shop student include; prevocational education, industrial arts, general mathematics, geometry, and mechanical drawing.

The machinist student should be able to add, subtract, divide, and multiply fractions and decimals. The student should be able to convert fractions to decimals and should be able to perform accurate fractional linear measurements.

The machinist student should be able to comprehend the meaning of technically written instructions and follow the sequence of a set of directions.

Being mechanically inclined will help the student machinist in using the tools and machines required in the trade and in understanding the often complex mechanisms that must be repaired or constructed.

The prospective machinist should be able to work independently, concentrate on a job which sometimes may be tedious and repetitious, and change from one task to another as required.

REQUIRED INSTRUCTION HOURS:

System	Year
Division	Class
Credits	3
Hours	540

LEVEL: Secondary

TITLE: Machine Shop II

DESIGNATION: MACHINE SHOP II COMPUTER NUMBER: 760

DESCRIPTION: The second year of machine shop study emphasizes: Shop safety; linear, angular, radii, vernier, x-y-z axis and quadrant measuring; bandsaw blade welding and annealing; use and care of the shaper; toolpost grinding; precise milling head alignment procedures; lathe and mill projects; use of the drill press; grinders; tailstock offsetting formulas and tailstock alignment; basic metallurgy; inspection of machined parts; charts, graphs, records, production gages, and inspection devices; as well as use of the hydraulic press and heat treating.

The second year of machine shop includes a hands-on introduction to Computer Numerically Controlled (CNC) precision machining through the use of the ENCO Compact 5 CNC trainer, similar in operation to production machines but designed for practical classroom learning experiences in basic lathe and milling operations.

OBJECTIVES: The graduate of Machine Shop II will be able to successfully set up and operate machine tools (such as the lathe, milling machine, shaper, or grinder) and fit and assemble components to make or repair metal parts, tools, and machines.

The graduate will be prepared to interpret specifications, blueprints, sketches, or measurements to determine dimensions and tolerances of a piece to be machined; the sequence of operations and the tools, materials, and machines required. The graduate will be able to measure, mark, and scribe dimensions and reference points to layout stock for machining.

The Machine Shop graduate will be able to: verify conformance of a workpiece of specifications by using various precision measuring instruments; position and secure a workpiece in a holding device and use hand tools such as files and wrenches to fit and assemble parts. The graduate will be able to verify dimensions and alignment using measuring instruments such as micrometers, gages, and calipers.

PROFICIENCY EVALUATION: Competencies of the Machine Shop II student will be measured by written outcome-referenced transfer and performance type testing as well as simulated/actual performance testing. The minimum competency standards are those recommended by industry for entry level job success in machining and are described in this *Articulated, Performance-based Instruction Guide for Machine Shop* (secondary curriculum guide).

The secondary Machine Shop program graduate will be able to use a safe and analytical problem solving approach in applying fundamental machining theory to practical situations. The graduate will know where to seek technical information and other pertinent data when it is needed.

In addition to the skills outlined in Machine Shop I, the graduate of the two year secondary program in machining will be competent to accomplish the following:

- Sharpen high speed steel tool bits and drills
- Turn diameters to +/- .001
- Accurately select speeds and feeds for the job
- Surface grind flats and angles to +/- .0005
- Layout and inspect work with indicator height gage, sine bar, and gage blocks to specifications
- Mill radii, slots, and irregular shapes to specifications
- Drill, bore, ream, and tap to commercial tolerances

- Set-up vises and locate work on rotary tables, mount work on angle plate, sine bar, and chucks to tolerances +/- .001

PREREQUISITES: Machine Shop I

Suggested Grade Level: 12

The Machine Shop I graduate should have demonstrated an interest in and aptitude for the study of advanced machine shop including the necessary mathematical skills, an ability to concentrate on and complete a repetitive and tedious task, as well as the fundamental skills and knowledges necessary to succeed in advanced machine shop study.

REQUIRED INSTRUCTION HOURS:

System	Year
Division	Class
Credits	3
Hours	540

TOTAL REQUIRED INSTRUCTION HOURS FOR THE SECONDARY MACHINE SHOP PROGRAM:

System	2-Years
Division	Class
Credits	6
Hours	1,080

WORKING CONDITIONS: The machinist should be prepared to work with machinery and materials that may be oily or greasy, like to work with tools and machines, and enjoy the challenge of precision work.

The machinist must be able to read, write, and understand technical words, instructions, and abbreviations. The machinist should be able to interpret plans and blueprints, visualize objects, and be able to think ahead and plan work in a series of steps. The machinist should be able to work alone and concentrate on precision work.

Physically, the machinist should have good vision, with correction if necessary, to be able to see fine details. Standing for periods of 2-4 hours at a time should be expected. Work may require minutely accurate measurements with small tools. Machine shop work typically requires reaching, squatting, bending, and twisting.

Generally, modern machine shops are clean, well lighted and ventilated and many may be air-conditioned, especially in industries. Noise levels may occasionally be high and the machinist may have to use hearing safety devices.

High speed machining equipment, sharp tools and metals, and heat equipment involve certain dangers. The machinist generally must wear safety glasses or face shields for eye or face protection and should wear appropriate clothing to prevent cuts or burns or getting caught or mangled in a machine.

EMPLOYMENT PROJECTION:

The South Carolina Employment Security Commission has projected a growth of approximately 20.6 percent to occur in the machining trade in the Greenville-Spartanburg area in the five year period between 1980 and 1985. This growth represents an estimated expansion of about 60 jobs to occur between 1983 and 1985 when the total machinist employed in the Greenville-Spartanburg area should be around 1,170. This estimate, however, may not take into account the number of machinists that may be practicing in related fields or as independent small businessmen.[1]

Typical employment will be in factories or industries which are growing substantially in Greenville County and surrounding area.

Some employers may require the secondary level Machine Shop graduate to enter an apprenticeship program while other opportunities may exist for the graduates with advanced skills to enter all-round machine work or specialized work gaining additional skills on-the-job.

To successfully compete in a growing technological business/industrial community, the high school graduate should seriously consider the advantages of additional educational preparation at Greenville Technical College in Machine Technology, the Tool-and-Die option, or in computer assisted machining (CAM) training. The machinist should pursue related training in areas such as mathematics and physics to prepare for high technology work that may involve hydraulics, electronics, robotics and computer assisted machine-control systems, and newer metalworking technologies.

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[1] South Carolina Occupational Projection, 1978-1985, Columbia, SC: South Carolina Employment Security Commission (Research & Analysis Department, p. 158, 1982.

The secondary Machine Shop program is designed to prepare graduates primarily as an entry-level apprentice

Machinist, D.O.T. 600.280-022

Other possible job areas include:

Grinder Operator, D.O.T. 603.280-018
Drill Press Operator, D.O.T. 606.682-014
Milling Machine Operator, D.O.T. 605.685-030
Lathe Operator, D.O.T. 604.685-026

Related occupations include: machine tool operators, production inspector, tool-and-die makers (with additional training), setup workers, and instrument makers as well as metal patternmakers, or even locksmiths.

SECONDARY LEVEL
STATE DEPARTMENT OF EDUCATION
RECOMMENDED PROGRAM

MACHINE SHOP

Machine Shop is a two year high school program typically involving 3-hour instructional blocks for the 180 day school year of 1,080 hours for the two year program.

The machinist student learns to read and interpret technical information; select and use semi-precision and precision measuring and gaging tools such as the micrometer or surface, depth, or dial gages; selecting, using and maintaining hand tools; setting up, operating and maintaining machines such as the drill press, cutoff saw, engine lathe, turret lathe, shaper, vertical and horizontal milling machines, surface grinder, and tool grinder. The machine shop student learns the proper selection, use and maintenance of cutting tools; identifying the properties of materials, and how to plan and layout work. Occupational safety and employability skills are integrated into the program.

Suggested topics that Machine Shop should include are:

1. Safety
2. Industrial processes
3. Drawing and blueprint reading
4. Materials (metals)
5. Work planning and layout
6. Math and measuring instruments
7. Hacksaw
8. Bandsaw
9. Benchwork
10. Engine lathe
11. Drilling machine
12. Shaper
13. Milling machine
14. Grinding machine
15. Welding and heat treating

Outline of High School Credit Courses, Columbia, SC: SC State Department of Education, pp. 135-136, 1980, (locally revised for accuracy).

Defined Minimum Program for South Carolina School Districts, Columbia, SC: SC Department of Education, 1980.

GREENVILLE TECHNICAL COLLEGE
MACHINE TOOL TECHNOLOGY
(Post-secondary Level)

The Machine Tool Technology Curriculum is designed to supply the students with the basic skills and necessary related information to enable them to develop into skilled machinists and tool makers. Graduates of the program may find employment in such positions as machinists, apprentice tool and die makers, and tool designers. Upon completion of the first year of study, the student may graduate with a Machinist diploma or continue for a second year in Tool and Die Making. The two-year program awards an Associate in Applied Science Degree.

Required courses - Machine Tool Technology	75 credit hours
Required courses - General Education	48 credit hours
Minimum requirements to graduate	123 credit hours

Suggested Sequence of Required Courses:

FIRST QUARTER

COURSE NUMBER	COURSE TITLE	CLASS	LAB	CREDIT
MAT 112	Applied Mathematics I	5	0	5
EGT 180	Blueprint Reading & Sketching I	5	0	5
MTT 111	Machine Shop Theory & Practice I	3	12	7
		13	12	17

SECOND QUARTER

COURSE NUMBER	COURSE TITLE	CLASS	LAB	CREDIT
MAT 122	Applied Mathematics II	5	0	5
EGT 110	Mechanical Drafting I	2	3	3
MTT 121	Machine Shop Theory & Practice II	3	12	7
		10	15	15

THIRD QUARTER

COURSE NUMBER	COURSE TITLE	CLASS	LAB	CREDIT
MAT 132	Applied Mathematics III	5	0	5
EGT 151	Industrial Drafting II	5	0	5
MTT 131	Machine Shop Theory & Practice III	3	12	7
ECO 100	Consumer Economics	3	0	3
		16	12	20

FOURTH QUARTER

COURSE NUMBER	COURSE TITLE	CLASS	LAB	CREDIT
ENG 150	Introduction to Composition	4.5	0	4.5
PSY 112	Industrial Human Relations	3	0	3
MTT 141	Machine Shop Theory & Practice IV	3	12	7
MTT 113	Metals & Heat Treatment	4	0	4
		14.5	12	18.5

TOOL AND DIE MAKING OPTION

FIFTH QUARTER

MTT 211	Tool & Die Making	4	12	8
MTT 232	Jigs & Fixtures	5	0	5
MAT 212	Applied Math IV	5	0	5
		14	12	18

SIXTH QUARTER

MTT 221	Tool & Die Making II	4	12	8
MTT 242	Jigs & Fixtures II	2	3	3
MTT 213	Basic Ferrous Metallurgy	3	3	4
MTT 135	Electrical Discharge Machining I	2	0	2
		11	18	17

SEVENTH QUARTER

MTT 231	Tool & Die Making III	4	12	8
MTT 215	Basic Die Theory	5	0	5
ENG 236	Advanced Technical Composition & Communication	4.5	0	4.5
		13.5	12	17.5

*ELECTIVES

MTT 100	Introduction to Machine Tools I	2	3	3
MTT 140	Introduction to Machine Tools II	2	3	3
MTT 151	Machine Shop Lathes	2	6	4
MTT 152	Machine Shop Milling Machines	2	6	4
MTT 124	Tool and Cutter Grinding	2	6	4

*Electives are not required for a diploma or degree program.

Source: Engineering Technology Division, Greenville Technical College, 1982-1984 (Catalog), Greenville, SC: Greenville Technical College.

Machine Technology Department, Greenville Technical College, 1984.

MAT 112 APPLIED MATHEMATICS I:

Included are operations with fractions, decimals, percentages, and formulas. Use of measurements and industrial applications are stressed. (5-0-5)

EGT 180 BLUEPRINT READING & SKETCHING I:

This is a study of basic blueprint reading and sketching. It includes a detailed study of layout, projection, and dimensioning. The student completing this course should be able to make sketches of certain geometric shapes and be able to orthographically project these shapes. The student should be able to read and interpret most shop drawings. (5-0-5)

MTT 111 MACHINE SHOP THEORY & PRACTICE I:

The student will become familiar with the operation of the drilling machine and the lathe. A rigid indoctrination in the basic handling of machinist hand tools, precision measuring tools and basic machine tool operational procedures will be given. The student will also learn how to sharpen drills and lathe cutting tools. Safety and good housekeeping will be taught and stressed at all times. (3-12-7)

MAT 122 APPLIED MATHEMATICS II:

Continuation of elementary algebra through quadratic equations. Elementary plane and solid geometry. Industry applications. Prerequisite: MAT 112. (5-0-5)

EGT 110 MECHANICAL DRAFTING I:

An introduction to principles and practices of mechanical drafting, which includes a study of instrument drawings, technical lettering, geometrical constructions, orthographic projection of normal, inclined, oblique, and cylindrical surfaces, and principles for selection and use of size and location dimensions. (2-3-3)

MTT 121 MACHINE SHOP THEORY & PRACTICE II:

The student will increase his proficiency in the use of the lathe and drilling machine operations, and have the basic knowledge of the surface grinder, milling machine and shaper operation. This course will also expose the student to further experience with precision measuring instruments, lathe accessories for basic internal and external lathe operations and setups. (3-12-7)

MAT 132 APPLIED MATHEMATICS III:

Algebra, trigonometry, geometry and industrial applications are presented. Prerequisite: MAT 122 or equivalent. (5-0-5)

EGT 151 INDUSTRIAL DRAFTING II:

A course of study designed to prepare students to complete multiview orthographic views of objects. Problems will be selected to include auxiliary and section views. Dimensions and notes, limits and tolerances, screw threads and fasteners will be studied and related to preparation of working drawings. Prerequisite: EGT 110. (5-0-5)

MTT 131 MACHINE SHOP THEORY & PRACTICE III:

The student will be able to operate the surface grinder, milling machine and shaper to produce advanced projects. Also, he/she will be able to operate the cylindrical grinder for external grinding operations and study internal grinding. Safety and good housekeeping will be stressed at all times. (3-12-7)

ECO 100 CONSUMER ECONOMICS:

Emphasizes the role of the consumer in our society. It includes consumer decision making, money and marital happiness, money management, consumer credit, intelligent shopping, financing a home, transportation, health services, estate planning and consumer protection. (3-0-3)

ENG 150 INTRODUCTION TO COMPOSITION:

A study and application of the principles of grammar, mechanics, and rhetoric as preparation for business and technical writing. The course will include writing correct and effective paragraphs and essays of various types, including expository, narrative, and descriptive. (4.5-0-4.5)

PSY 112 INDUSTRIAL HUMAN RELATIONS:

Provides supervised experience and instruction designed to help the student recognize and develop the traits necessary for good relations with fellow workers, supervisors, subordinates, customers and others. Through exercises involving awareness, self-concept and self-evaluation, role-playing, and group and individual problem solving, the course will help to develop improved interpersonal relationships. (3-0-3)

MTT 141 MACHINE SHOP THEORY & PRACTICE IV:

The student will be able to produce and complete projects using all basic machine tools with a minimum of supervision. In this course, advanced work with basic machine tools, producing industrial style projects will be accomplished in the development of accuracy, speed, safety, workmanship, and skill. (3-12-7)

MTT 133 METALS & HEAT TREATMENT:

The student will be able to select steel by its color codes and have an understanding of heat treatment terminology, procedures, and testing. The student will also study the elementary principles concerning metals, their production, composition, individual properties and uses. (4-0-4)

MTT 211 TOOL & DIE MAKING:

The student will be able to machine and construct to tolerance, simple cutting dies or tool gages to industrial style prints. This course will offer the student the theory and practice of precision machining on all tool room equipment. Safety and good housekeeping will be stressed at all times. (4-12-8)

MTT 232 JIGS & FIXTURES:

The student will be able to design simple jig and fixtures to local industrial standards. This course of study will be of the theory involved in designing jigs and fixtures. By following industrial procedures and tolerances, the student will design working drawings of drill jigs and milling fixtures. (5-0-5)

MAT 212 APPLIED MATH IV:

Course includes algebra, trigonometry, geometry and further industrial applications. Prerequisite: MAT 132 or equivalent. (5-0-5)

MTT 221 TOOL & DIE MAKING II:

The student will be able to machine and construct to tolerance, simple cutting dies or tool gages to industrial style prints. This course will offer the student the theory and practice of precision machining on all tool room equipment. Safety and good housekeeping will be stressed at all times. (4-12-8)

MTT 242 JIGS & FIXTURES II:

The student will be able to design complex jigs or fixtures or construct a simple jig and fixture in the lab or meet local industrial standards. This course is a continuation of MTT 232, leading to more complex designs, or the construction of jigs and fixtures designed previously. (2-3-3)

MTT 213 BASIC FERROUS METALLURGY:

The student will know the basic fundamental of metallurgy and will be able to heat, treat, and test metals for various results desired. This course will present the general theory and practical application of the structure, behavior and heat treatment of ferrous metals used in the manufacture of tools, dies, and other industrial products. (3-3-4)

MTT 135 ELECTRICAL DISCHARGE MACHINING I:

The student will have an understanding of the types of machining operations performed by electrical discharge machining and its application in manufacturing. (2-0-2)

MTT 231 TOOL & DIE MAKING III:

The student, using his/her basic tool and die theory, will be able to construct more complex tooling with minimum assistance. Dies such as cutting, blanking, and piercing and/or advanced tooling will be constructed and put into trial operation. Press safety will be emphasized. (4-12-8)

MTT 215 BASIC DIE THEORY:

The student will have knowledge of die components as they relate to the complete die. Essential facts of cutting and forming operations are explained, and related to the manner in which the dies must function in order to achieve the desired results. (5-0-5)

ENG 236 ADVANCED TECHNICAL COMPOSITION & COMMUNICATION:

Instruction in the theory and practice of planning and writing effective business and technical compositions. A research project reflecting acceptable writing styles and basic knowledge of the student's major area of study is required. Techniques of oral communication and presentations will be covered. Prerequisite: ENG 150 or ENG 101 and completion of first year of the student's major. (4.5-0-4.5)

MTT 100 INTRODUCTION TO MACHINE TOOLS I:

A course in the identification, use, capabilities and characteristics of basic machine tools in industry. Emphasis will be placed on basic measuring tools, machine setup, and demonstration of the drill press, engine lathe, milling machine, shaper, and grinder. Students will be introduced to such operations as drilling, milling, turning, shaping, tapping, reaming, boring, and grinding. (2-3-3)

MTT 140 INTRODUCTION TO MACHINE TOOLS II:

The student will learn the limitation of machine tool operation. This course is a continuation of MTT 100, with the student operating the basic machines. (2-3-3)

MTT 151 MACHINE SHOP LATHES:

The student will be able to operate the lathe and to produce projects containing the main features of lathe work. The student will be able to setup and operate the lathe and work to close tolerances, grind lathe cutting tools and use the correct speed and feed for material being machined. The student will be able to use all of the lathe attachments. (2-6-4)

MTT 152 MACHINE SHOP MILLING MACHINES:

The student will be able to operate the milling machine to produce projects containing the main features of milling machine work. This course will cover the theory and practice of basic and advanced milling machine operations. The student will use all types of cutters, setups, and be able to select the correct speed and feed for all types. (2-6-4)

MTT 124 TOOL AND CUTTER GRINDING:

The student will be able to resharpen the various cutting tools to suit various metals. This course will stress wheel safety and selection. The cutting tools to be ground will be general machine shop items such as drills, lathe tools, bits, and end mills. (2-6-4)

SURVEY RESULTS
SECONDARY MACHINE SHOP LAB FACILITIES
(for articulation purposes)

A survey of the secondary Machine Shop program yielded the following information concerning the major types of machines, equipment, and measuring tools that are available for instruction.

For articulation purposes, the survey results indicates similar machine shop training equipment at the three secondary career centers.

The survey does not reflect the age or condition of the measuring instruments or machines and, in some cases, the training equipment may be deadlined or in need of repairs.

Greenville Technical College's Machine Technology program was omitted from the survey since the post-secondary program features equipment similar or equivalent to that found in local industry, including NC/CNC technology. Equipment in the TEC Machine Technology program is updated regularly through industrial donations, grants, and other activities that have allowed the program to become a resource center for machine technology training in the State and Nation.

	CAREER CENTER		
Gages and Measuring Equipment (larger)	Donaldson	Enoree	Foothills
Go-No Go Ring Gages			
Dial Bore Gage			
Dial Depth Gage			
Cylindrical Square			
Optical Flat			
Gage Blocks	x	x	x
Comparator	x		
Optical Comparator	x		
Bench Center			
Sine Bar	x	x	
Snap Gages			
Vernier Height Gage	x	x	x
Height Micrometer			

Machine Shop Equipment

Pedestal Grinder	x	x	x
Drill Press	x	x	x
Horizontal Band Saw	x	x	x
Vertical Band Saw	x	x	x
Power Hacksaw			x
Engine Lathe	x	x	
Milling Machine	x	x	x
Turret Lathe	x	x	x
Shaper	x	x	
Tool & Cutter Grinder	x	x	x
Surface Grinder	x	x	x
Cylindrical Grinder			x
Welder	x	x	
Heat Treatment Equipment	x	x	
Hydraulic Press	x	x	
NC/CNC Trainer: Emco Compact 5 CNC Lathe	x	x	x

This survey results page is accompanied by page of definitions of gaging tools.

BEST COPY AVAILABLE

DEFINITIONS
SURVEY OF TRAINING EQUIPMENT

GAGING TOOLS

DIAL BORE GAGE	Used to check the bore of parts to .0001 accuracy, preset with a ring gage.
DIAL DEPTH GAGE	Used to check depth of holes, slots, and grooves, and recesses.
CYLINDRICAL SQUARE	Used as meter against which other squares may be checked.
CYLINDRICAL PLUG GAGE	Has "go" and "no-go" ends, used to check bore of parts to .0001 accuracy.
OPTICAL FLAT	Uses light waves to measure flatness, parallelism, and size.
GAGE BLOCKS	Used to check measurements, set fixed gages, calibrate measuring tools, set comparators, inspect and perform other set-ups (.000001).
COMPARATOR	Used to inspect size of parts from a flat surface.
BENCH CENTER	Used to check concentricity of machined parts.
SINE BAR	Used to set up or inspect angular surfaces.
SNAP GAGES	Used to check parts within certain limits of a predetermined, fixed dimension.
VERNIER HEIGHT GAGE	Used as a vertical caliper to scribe lines within .0001 inch in layout, to measure depth, and to gage a machined surface.
HEIGHT MICROMETER	Used to set other measuring tools for inspection by comparison, accurate to .00001 inch.
SURFACE PLATE	A reference plane for precision measurement; when used with other gages, the surface plate becomes a gage itself.

Some measuring instruments were omitted if they typically are standard items in a machine shop classroom or if they may be classified as expendable measuring tools.

SURVEY RESULTS
CURRENT SECONDARY LEVEL USE OF MACHINE SHOP
CAREER CLUSTER PROJECT: 1972-1976

The three secondary career center machine shop programs of The School District of Greenville County were surveyed to determine the current use of the 1976 Career Cluster Project material. The Career Cluster Project yielded audio-visual training aids as well as validated competency statements.

The intent of the Career Cluster project was to promote a "region-wide coordination of vocational-technical training program in South Carolina Appalachia." Through job related training objectives, the program intended to promote a smooth transition from secondary vocational training to post-secondary technical training.

The secondary machine shop instructors participating in the articulation program reported the following use of the Career Cluster project materials.

CAREER CENTER (Secondary)	YES	NO	%
Donaldson		x	
Enoree	x*		*
Foothills		x	

*To limited degree during
1st year of training.

The primary reasons the instructors gave for not using the Career Cluster Project material include; poor quality of audio-visual materials, extensive bookkeeping requirements on instructor, and instructor's findings that students still had to be "shown" (taught) by the instructor in addition to being taught by the Career Cluster A/C materials (i.e., The Lap Program in general did not improve the learning situation and required more instructor time.).

The purpose of this survey was to identify the degree of use of the Career Cluster Program materials and, as much as possible, to salvage objectives and competency statements from the program.

STANDARDS APPLICABLE TO MACHINE SHOP
(Secondary Level)

- Performance-based objectives assume that the workpiece or stock provided for training is mild steel. The task objective will clarify the standards, specifications, and procedures when a metal stock other than mild steel is used. Other materials used for training include aluminum, plastic, etc.

- This articulated guide is based on a three-hour per day training period. The time allocated for training is 1,080 hours for two years or 540 hours per year. No time is allocated for the busing of students between the parent high school and the career center, for coke breaks, or for other non-training activities.

- Objectives and performance actions (enabling objectives) are designed on the assumption that instructional materials such as metal stock and fully operational equipment accompanies by the typical support accessories are available for training. If articulated training objectives cannot be met due to lack of training materials or equipment, the instructor should be informed by the student, the instructor should enter a note in the articulated instruction guide on the appropriate task objective page, and appropriate measures should be taken to correct the situation so that training objectives may be met.

UNIT 1.0

Unit 1.0, Introduction/Orientation, has been designed to represent introductory requirements of the vocational program such as course policies, procedures, and safety regulations; leadership training, desirable work attitudes and habits that potential employers recommend be incorporated in secondary instruction, career information, and basic math and related skills necessary for success in the vocation.

Some task objectives that are described in this first unit naturally will be learned early in the instructional program while competencies in other tasks may result during the first year or second year. For example, students must understand the policies of the program very early in the first year but may not develop competencies in job attitudes or career information until the second year. Job habits and attitudes typically will be taught during the entire two year training program.

UNIT 1.0 A	INTRODUCTION/ORIENTATION
UNIT 1.0 B	INTRODUCTION TO SAFETY
UNIT 1.0 C	INTRODUCTION TO LEADERSHIP/ JOB COMMUNICATIONS
UNIT 1.0 D	PREPARING FOR WORK
UNIT 1.0 E	INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/HABITS/ATTITUDES
UNIT 1.0 F	BASIC MATH SKILLS
UNIT 1.0 G	BASIC MEASURING
UNIT 1.0 H	INTRODUCTORY BLUEPRINT READING
UNIT 1.0 I	WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

MACHINE SHOP
INTRODUCTION/ORIENTATION
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 1.0 A	INTRODUCTION/ORIENTATION	
1.01	Review/Follow Career Center Policies and Procedures	3
1.02	Orientation to Vocational Program Classroom/Shop/Lab	1
1.03	Review Course Objectives and Standards	3
Unit 1.0 B	INTRODUCTION TO SAFETY	
1.01	General Safety Orientation	1
1.02	Identify Desirable Vocational Training Safety Habits	*
1.03	Observe Classroom Safety Practices	1
1.04	Apply Fire Safety Rules and Procedures	1
1.05	Apply Electrical Safety Rules and Procedures	
1.06	Observe Personal Safety Practices	1
Unit 1.0 C	INTRODUCTION TO LEADERSHIP/ JOB COMMUNICATIONS	
1.01	Work Cooperatively With Fellow Students	N/A
1.02	Demonstrate Desirable Characteristics of Leadership	N/A
1.03	Participate in VICA Club Activities	N/A
1.04	(OPTIONAL) Demonstrate Proper Use of Parliamentary Procedure	N/A
1.05	(OPTIONAL) Communicate a Message by the Medium of a Speech	N/A

*Integrated

Unit 1.0 D	PREPARING FOR WORK	
1.01	Describe the Free Enterprise System and the Difference Between Labor and Management	N/A
1.02	Interpret Labor Laws and Regulations	N/A
1.03	Interpret Payroll Deductions for Taxes, Etc.	N/A
1.04	Identify Typical Career Opportunities	1
1.05	Locate Job Opportunities	--
1.06	(OPTIONAL) Prepare Resume	2
1.07	Compose Application Letter	--
1.08	Complete a Typical Employment Application Form	3
1.09	Interview for a Job	3
1.10	(OPTIONAL) Compose Follow-up Letter	--
1.11	Identify Post-secondary Career Development Opportunities	6
Unit 1.0 E	INTRODUCTION TO DESIRABLE JOB/ LEARNING CHARACTERISTICS/HABITS/ ATTITUDES	
1.01	Describe Good Work Habits Important to Job Success	N/A
1.02	Exhibit Successful Job Performance Characteristics	3
1.03	Exhibit Desirable Work Attitudes	3
1.04	Demonstrate Care for and Respect of School Property	N/A
Unit 1.0 F	BASIC MATH SKILLS	
1.01	Basic Math - Fractions	6
1.02	Basic Math - Decimals	6
1.03	(OPTIONAL) Basic Math - Volumes	1

1.04	(OPTIONAL) Basic Math - Areas	1
1.05	(OPTIONAL) The Metric System	1
Unit 1.0 G	BASIC MEASURING	
1.01	Measuring	6
Unit 1.0 H	INTRODUCTION BLUEPRINT READING	
1.01	Interpret Multiview Drawings	6
1.02	Determine Dimensions and Tolerances	12
1.03	Interpret Pictorial Drawings	3
Unit 1.0 I	WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS	
1.01	Write Technical Information Concerning Machining Operations	3
1.02	Read Technical Information Concerning Machining Operations	3
	TOTAL HOURS	81

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
1.01	(Review/Follow Career Center Policies and Procedures) Given information on career center policies and procedures, apply these policies and procedures on a day-to-day basis.
1.02	(Orientation to Vocational Program Classroom/Shop/Lab) Given information on school shop or instructor's policies and procedures, apply these policies and procedures on a daily basis, meeting the standards of the instructor 100 percent.
1.03	(Review Course Objectives and Standards) Given an introduction to the vocational program, a review of the course objectives and minimum standards of performance; describe the course objectives, and the minimum performance expected to demonstrate competency in the objectives.
UNIT 1.0 B	INTRODUCTION TO SAFETY
1.01	(General Safety Orientation) Given an orientation to building, shop, and fire safety; discuss, identify, or demonstrate general shop safety behavior and fire procedures.
1.02	(Identify Desirable Vocational Training Safety Habits) Given an introduction/orientation to general safety as well as to safety in the vocational education program or on the job; identify general occupational safety habits to the satisfaction of the instructor and meeting all applicable safety rules and regulations.
1.03	(Observe Classroom Safety Practices) Given a typical vocational classroom/shop/lab or job situation, exhibit an awareness of safety practices, safe work habits, and a positive attitude concerning job safety and accident prevention and meet standards established by the instructor.
1.04	(Apply Fire Safety Rules and Procedures) Given examples of types of fires, fire extinguishers, and possible shop situations, apply fire safety rules and procedures. Meet the National and local fire safety procedures.
1.05	(Apply Electrical Safety Rules and Procedures) Given orientation to identifying electrical hazards, apply electrical safety rules and procedures. Electrical equipment, exposed wire, frayed cables, and deteriorated insulation must be reported and corrected. Proper grounding must be employed and maintained. Junction boxes, outlets, switches, breaker switches, and panels must be identified as to their use. Meet all applicable National and local standards and the standards of the instructor.

1.06 (Observe Personal Safety Practices) Given instruction, identify personal safety clothing, equipment, or procedures to ensure safety in the vocational field/training, with 100 percent accuracy, demonstrating proper use or safety behavior.

UNIT 1.0 C INTRODUCTION TO LEADERSHIP/JOB COMMUNICATIONS

1.01 (Work Cooperatively With Fellow Students) Given instruction and an opportunity to meet fellow students in the vocational program environment, work cooperatively with fellow students as well as with other students in related vocational learning activities. Meet the instructor's standards and cooperate to the satisfaction of fellow students as a group.

1.02 (Demonstrate Desirable Characteristics of Leadership) Given an introduction/orientation to desirable qualities of a good leader, describe characteristics typical of a good leader, discuss desirable leadership qualities, and demonstrate an ability to follow as well as take a leadership position. Performance should be satisfactory to the instructor and fellow students.

1.03 (Participate in VICA Club Activities) Given an introduction/orientation to the Vocational Industrial Club of America (VICA), describe the general purposes of VICA, describe a typical VICA program at a vocational center, recall from memory the VICA motto, state the VICA pledge from memory, identify the symbols/symbolism in the VICA emblem, identify what the colors of the VICA organization represent. Performance should be acceptable to the VICA Club sponsor, instructor, and VICA Club members.

1.03 (Demonstrate Proper Use of Parliamentary Procedure) Given instruction, apply the principles of parliamentary procedure and describe the characteristics of a good chairman.

1.03 (Communicate a Message by the Medium of a Speech) Given instruction, list purposes of a speech, characteristics of a speech, and write and orally deliver a speech. The delivered speech should contain accurate information, be technically correct in organization and delivery, and the intended message should be communicated.

UNIT 1.0 D PREPARING FOR WORK

1.01 (Describe the Free Enterprise System and the Difference Between Labor and Management) Given an introduction/orientation to the free enterprise system of economics, describe to the satisfaction of the instructor the free enterprise system of economics as found in the United States and describe the relationship between labor and management.

1.02 (Interpret Labor Laws and Regulations) Given instruction, necessary references concerning labor laws and regulations; interpret typical labor laws and regulations. Performance must meet the instructor's standards.

1.03 (Interpret Payroll Deductions for Taxes, etc.) Given instruction and sample forms concerning income tax and other withholdings; interpret the typical forms used in income tax and other withholdings to the satisfaction of the instructor and itemize typical payroll deductions that a worker encounters. Performance must be to the instructor's standards.

1.04 (Identify Typical Career Opportunities) Given instruction, data on the local business and industry, opportunities to study entry-level job opportunities; identify the major categories of potential employers in the local community (and the key characteristics of each).

1.05 (Locate Job Opportunities) Given job placement information such as newspaper ads and personal contacts, list a minimum of ten specific jobs in the community. One week will be allowed to complete the task.

1.06 (Prepare Resume) Given examples of suitable resume/personal data sheets, prepare and type (or print at a minimum) a personal resume on paper acceptable to the instructor with all errors acceptable corrected.

1.07 (Compose Application Letter) Given a newspaper ad for a job, compose a letter of application. The letter must be mailable and include the necessary personal information.

1.08 (Complete a Typical Employment Application Form) Given an employment application form typical of the job, complete the form with all information accurate, neatly typed or printed in an aligned in the form blanks.

1.09 (Interview for a Job) Given instruction on how to interview for a job, a job interview checklist, and a mock job interview; complete a job interview to the satisfaction of the instructor.

1.10 (Compose Follow-up Letter) Given a case situation by the instructor or from the textbook, compose and write a follow-up letter appropriate to the job application or interview situation and in mailable form. The finished letter must meet the instructor's standards.

1.11 (Identify Post-secondary Career Development Opportunities) Given an orientation to similar post-secondary career development programs, primarily the similar vocational programs at Greenville Technical College but including continuing education programs as well, a report of skill competencies developed during secondary training, and other information as needed; identify post-secondary career development opportunities.

UNIT 1.0 E INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/HABITS/ATTITUDES

1.01 (Describe Good Work Habits Important to Job Success) Given introduction/orientation to desirable work habits, as described by potential employers or tradesmen, demonstrate desirable (good) work habits based on information provided by the instructor to represent the minimum standards expected by business/industry (potential employers) for entry employment success.

1.02 (Exhibit Successful Job Performance Characteristics) Given instruction, demonstrate job performance characteristics that are considered important to entry-level career success in the vocational field. A "Job Performance Rating Sheet" will be used to evaluate performance and all items must be rated "frequently" or above.

1.03 (Exhibit Desirable Work Attitudes) Given instruction, demonstrate work attitudes that the majority of potential employers prefer in an entry level worker. Performance will be evaulated on a "Work Attitudes Score Card" and a minimum of 90 percent should be attained. Performance will be rated through training and should improve to 100 percent by the end of the training period.

UNIT 1.0 F BASIC MATH SKILLS

1.01 (Basic Math - Fractions) Given a pretest or examples of the instructor, conduct the following operations with fractions:

1. Change any fraction to a decimal number, and any terminating decimal number to a fraction.
2. Arrange in order...unit and simple nonunit fractions.
3. Write equivalent fractions in higher, lower, lowest terms.
4. Write improper fractions as whole or mixed numbers, and mixed numbers as improper fractions.
5. Multiply fractions and mixed numbers, expressing answers in simplest form.
6. Divide fractions and mixed numbers, expressing answers in simplest form.
7. Add and subtract unlike fractions, expressing answers in simplest form.
8. Add and subtract mixed numbers with unlike fractions, expressing answers in simplest form.
9. Use rational numbers to solve simple work problems.

1.02 (Basic Math - Decimals) Given a pretest or examples by the instructor, conduct the following decimal math operations:

1. Name the place value of digits in decimal numbers on up to nine digits before the decimal and six digits after the decimal.
2. Compare decimal numbers and arrange them in order.
3. Write the numeral for any decimal number of up to four decimal places.
4. Round decimal numbers to any designated place value up to thousandths.
5. Add and subtract decimal numbers of up to six digits.
6. Multiply decimal numbers by whole numbers or decimal numbers.
7. Divide a number by a three-digit decimal number.
8. Multiply and divide decimal numbers by powers of ten, by inspection.

1.03 (Basic Math - Volumes) Given a pretest or examples by the instructor, find the volume of any rectangular prism or cube.

1.04 (Basic Math - Areas) Given a pretest or examples by the instructor, find the area of the following types of figures:

a. Rectangle and square
b. Circle

1.05 (The Metric System) Given basic instruction in the metric system and conversion from United States Customary units to metric; read and convert specifications and dimensions from one system into the other system on teacher or text assigned problems with 100 percent accuracy.

UNIT 1.0 G BASIC MEASURING

1.01 (Measuring) Given proper instructions, read a rule and use other measuring tools with the precision necessary to take measurements from drawings, and transpose them to exact working lengths and angles.

UNIT 1.0 H INTRODUCTORY BLUEPRINT READING

1.01 (Interpret Multiview Drawings) Given a selection of multiview blueprints or drawings (orthographic projections) complete with symbols, notations, dimensions, and tolerances, and the necessary reference materials; interpret the multiview drawings. All symbols, notations, dimensions, and tolerances must be identified. Side, top, and front wires must be identified from each drawing.

1.02 (Determine Dimensions and Tolerances) Given a selection of machine shop blueprints or drawings, and the necessary reference and writing materials, determine the dimensions and tolerances given on the drawings using dimensions lines, centerlines, projection lines, and views. Correct dimensions must be determined in order to machine the parts. Tolerances must be identified with 100 percent accuracy.

1.03 (Interpret Pictorial Drawings) Given a selection of pictorial drawings complete with symbols, notations, dimensions, and tolerances, and the necessary reference materials; interpret the pictorial drawings. All symbols, notations, dimensions, and tolerances must be identified.

UNIT 1.0 I WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

1.01 (Write Technical Information Concerning Machining Operations) Given instruction and an introduction to the secondary machine shop program and the terminology of the trade, write technical reports/communications that convey the intended messages and that can be read intelligently by another machinist student (or machinist). Student performance must be acceptable to the instructor.

The written message may include notations, etc., made on working drawings, specifications, technical instructions, or descriptions of machining operations using the proper terminology. The message intended must be communicated to the receiver.

While correct spelling and punctuation is desirable, emphasis will be on effective and efficient communications of a technical message.

1.02 (Read Technical Information Concerning Machining Operations) Given an introduction to the secondary machine shop program and the terminology used in the trade, read and interpret technical literature or information concerning machining operations. Reading competency should be demonstrated by the ability to read and interpret information from blueprints and specifications, technical instructions, and manufacturer's manuals on equipment. Student performance must be acceptable to the instructor.

UNIT 1.0 A

INTRODUCTION/ORIENTATION

UNIT 1.0 A INTRODUCTION/ORIENTATION

TASK 1.01 REVIEW/FOLLOW CAREER CENTER POLICIES AND PROCEDURES

PERFORMANCE OBJECTIVE:

Given information on career center policies and procedures, apply these policies and procedures on a day-to-day basis.

PERFORMANCE ACTIONS:

1.0101 Review center policies and procedures.

1.0102 Review philosophy of center and, The School District of Greenville County, and the South Carolina Department of Education.

1.0103 Review relevant safety policies and procedures under unit concerning safety, and practice desired safety behavior as outlined in relevant safety policies and procedures.

PERFORMANCE STANDARDS:

- Using information and materials, supplies, review and apply career center policies and procedures daily.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Career Center Student Handbook
- High School Student Handbook
- Written Policies and Procedures of The School District of Greenville County
- Policies and Procedures of the South Carolina State Department of Education
- "Authorization" and "release" forms (such as safety releases)

UNIT 1.0 A INTRODUCTION/ORIENTATION

TASK 1.02 ORIENTATION TO VOCATIONAL PROGRAM CLASSROOM/SHOP/LAB

PERFORMANCE OBJECTIVE:

Given information on classroom/shop or instructor's policies and procedures, apply these policies and procedures on a daily basis, meeting the standards of the instructor 100 percent.

PERFORMANCE ACTIONS:

1.0201 Review with instructor the shop policies and procedures.

1.0202 Apply, with 100 percent accuracy, the policies and procedures of the vocational program, shop, or instructor.

PERFORMANCE STANDARDS:

- Apply information/instruction given during orientation and throughout training period to comply with all policies and procedures of the shop (instructor) on a day-to-day basis.
- Standards of the State, School District, Career Center, and high school, and instructor apply.

SUGGESTED INSTRUCTION TIME: 1 Hour

RECOMMENDED:

- Vocational education (shop) policies and procedures should be written and posted or distributed to students.

UNIT	1.0 A	INTRODUCTION/ORIENTATION
TASK	1.03	REVIEW COURSE OBJECTIVES AND STANDARDS

PERFORMANCE OBJECTIVE:

Given an introduction to the vocational program, a review of the course objectives and minimum standards of performance; describe the course objectives, and minimum performance expected to demonstrate competency in given objectives.

(NOTE: This task may be accomplished in general at the beginning of the first year and in detail over the two year training period.)

PERFORMANCE ACTIONS:

1.0301 Review each major objective of the vocational program as outlined in this articulated, performance-based instruction objectives guide.

1.0302 Review the minimum performance standards of the objectives.

Possible Alternate Actions:

Instructor may require students to identify objectives and standards at the initiation of each new unit of instruction.

PERFORMANCE STANDARDS:

- Using information provided, explain the objectives of the course and describe the minimum performance for each objective.

SUGGESTED INSTRUCTION TIME: 3 Hours

RECOMMENDATION:

- Course objectives, (Task Listing objectives) should be written and posted or distributed to students.

UNIT 1.0 B

INTRODUCTION TO SAFETY

UNIT	1.0 B	INTRODUCTION TO SAFETY
TASK	1.01	GENERAL SAFETY ORIENTATION

PERFORMANCE OBJECTIVE:

Given an orientation to building, shop, and fire safety; discuss, identify, or demonstrate general shop safety behavior and fire procedures.

PERFORMANCE ACTIONS:

1.0101 As applicable, discuss basic safety rules applicable to the training facility.

1.0102 Identify general shop safety rules.

1.0103 a. Review fire safety rules with the instructor.
b. Identify fire safety equipment, exits, and procedures in the shop and building area during a fire.

PERFORMANCE STANDARDS:

- Follow basic safety rules and established shop safety practices.
- Follow established fire safety practices and procedures.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.02 IDENTIFY DESIRABLE VOCATIONAL TRAINING SAFETY HABITS

PERFORMANCE OBJECTIVE:

Given an introduction/orientation to general safety as well as to safety in the vocational education program or on the job; identify general occupational safety habits to the satisfaction of the instructor and meet all applicable safety rules and regulations.

PERFORMANCE ACTIONS:

1.0201 Listen to all information provided by the instructor or others concerning safety in the career center, vocational program, and in live learning activities.

1.0202 Observe safety posters.

1.0203 Observe safety warning devices for hazardous materials or work areas.

1.0204 Demonstrate correct safety practices going to and from the classroom/shop as well as in the classroom situation.

1.0205 Describe the effect of accidents on the production dollar, due to possible time loss.

1.0206 Observe learning situations or other situations for the observation of safe situations as well as violation of proper safety rules and regulations.

PERFORMANCE STANDARDS:

- To the standards of the instructor and standards applicable to the classroom or school or in the vocational field, demonstrate desirable occupational safety habits.
- "Zero" accidents.
- "Zero" safety violations.

SUGGESTED INSTRUCTION TIME: (Integrated training)

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.03 OBSERVE CLASSROOM SAFETY PRACTICES

PERFORMANCE OBJECTIVE:

Given a typical vocational classroom/shop/lab or job situation, exhibit an awareness of safety practices, safe work habits, and a positive attitude concerning job safety and accident prevention and meet standards established by the instructor.

PERFORMANCE ACTIONS:

1.0301 Develop an awareness of vocational training/job hazards and become more safety conscious.

1.0302 Develop a serious attitude toward the daily use of safety procedures.

1.0303 Prepare for safety before entering the training work area.

1.0304 Prepare for safety at the work station.

1.0305 Prepare for safety on existing the training work area.

1.0306 Demonstrate knowledge of general safety color coding in the training/job facility and on equipment and tools.

1.0307 Practice safe procedures/habits daily.

PERFORMANCE STANDARDS:

- "Zero-level" accident record in vocational program.
- Instructor's standards based on recommended resources.
- Applicable OSHA Standards.

SUGGESTED INSTRUCTION TIME: 1 Hour

POSSIBLE RESOURCES:

Current vocational program safety guide publication of The School District of Greenville County.

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.03 OBSERVE CLASSROOM SAFETY PRACTICES (Con't.)

POSSIBLE RESOURCES: (Con't.)

Jacobs, Clinton O., and Howard J. Turner, Developing Shop Safety Skills, Athens, GA: American Association for Vocational Instructional Materials. (Approximately 80 pages of brief, visually clear suggestions concerning a variety of shop safety situations. Good student or resource manual.)

RECOMMENDED RESOURCES:

Safety Handbook, A Guide for Trade and Industrial Programs, Clemson University, SC: Vocational Education Media Center, 1968. (No. 13/2/70, $2.25: Accompanying 31 Transparencies, No. 9/8/68, $5.75.) Available from Trades and Industries Division Supervisor, Office of Vocational Education, South Carolina State Department of Education or from the Vocational Education Media Center, Clemson University, SC.

Planning for Emergencies, Occupational Safety and Health Short Course Number Seven, Columbia, SC: SC State Board for Technical and Comprehensive Education.

Notgrass, Troy, Safety Handbook for ICT, The University of Texas at Austin: Center for Occupational Curriculum Development, Division of Continuing Education, 1978.

Hoerner, Thomas A., and Mervin D. Bettis, Power Tool Safety and Operation, St. Paul, MI: Hobar Publications, 1977.

RELATED TECHNICAL INFORMATION:

- Regulations of individual center or vocational program.
- Regulations of The School District of Greenville County.
- Codes, laws, and ordinances.
- Materials and equipment handbooks and manuals.
- OSHA Regulations.
- E.P.A. Regulations.

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.04 APPLY FIRE SAFETY RULES AND PROCEDURES

PERFORMANCE OBJECTIVE:

Given examples of types of fires, fire extinguishers, and possible shop situations, apply fire safety rules and procedures. Meet National and local fire safety procedures.

PERFORMANCE ACTIONS:

1.0401 Identify and explain application for fire extinguishers of the following types:

a. Form
b. Carbon Dioxide
c. Soda Acid
d. Pump Tank
e. Gas Cartridge
f. Dry Chemical
g. Multi-purpose Dry Chemical

1.0402 Describe procedures for operating selected fire extinguishers.

1.0403 Identify potential causes of fire in the vocational field/shop and common methods for avoiding or preventing fires.

1.0404 Inspect shop/laboratory for conformity with fire safety rules and procedures.

1.0405 Identify/explain relevant safety precautions applicable to vocational training activities.

PERFORMANCE STANDARDS:

- Apply applicable fire safety rules and procedures to the vocational program/training meeting all applicable standards, National, local, and instructor's.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.05 APPLY ELECTRICAL SAFETY RULES AND PROCEDURES

PERFORMANCE OBJECTIVE:

Given orientation to identifying electrical hazards, apply electrical safety rules and procedures. Electrical equipment with exposed wire, frayed cables, and deteriorated insulation must be reported and corrected. Proper grounding must be employed and maintained. Junction boxes, outlets, switches, breaker switches, and panels should be identified as to their use. Meet all applicable National and local standards and the standards of the instructor.

PERFORMANCE ACTIONS:

1.0501 Explain importance of labeling circuit breakers.

1.0502 Explain importance of proper grounding of machines or equipment of electrically operated hand tools.

1.0503 Demonstrated/explain methods for using flexible extension cords, long cables, or drop lights.

1.0504 Identify electrical hazards and explain safety rules pertaining the vocational field of training.

1.0505 Identify approved locations for all electrical equipment and power sources in the shop or at the training field location.

1.0506 Interpret safety precautions for electricity in the vocational shop.

PERFORMANCE STANDARDS:

- Apply electrical safety rules and procedures for the vocational shop/laboratory, including field training locations, on a day-to-day basis meeting all applicable National and local safety rules and regulations as well as the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 1 Hour

(NOTE: Specific safety procedures and recommendations pertaining to a tool and equipment item may be included as a part of the task description concerning the tool/equipment.)

UNIT 1.0 B INTRODUCTION TO SAFETY

TASK 1.06 PERSONAL SAFETY

PERFORMANCE OBJECTIVE:

Given instruction, identify personal safety clothing, equipment, or procedures to ensure safety in the vocational field/training, with 100 percent accuracy, demonstrate proper use or safety behavior.

PERFORMANCE ACTIONS:

1.0601 List and explain personal safety rules/procedures.

1.0602 Identify appropriate protective clothing/equipment/etc., used in the vocational field/training, possibly from a given list, sketch, or mock-up.

PERFORMANCE STANDARDS:

- Given a list, sketch, or mock-up, identify with 100 percent accuracy personal safety clothing, equipment, etc., used in the vocational field.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Additional personal safety training will be integrated into occupational task training.

Addendum to Safety Unit

STUDENT'S SAFETY PLEDGE
AND
PARENT'S/GUARDIAN'S PERMISSION FOR OCCUPATIONAL TRAINING

______________________________, as part of vocational education training, will use/operate potentially hazardious occupational tools, machinery, equipment, and materials typical of the vocational field; provided that the student pledges to follow all safety rules and regulations of the instructor/career center/The School District of Greenville County and provided that the student's parent or guardian grants permission for occupational training by signing the release below.

TO THE STUDENT:

The vocational student will be given proper instruction, both in the use of and correct safety procedures concerning occupational tools, machinery, equipment, and materials typical to the vocational field before being allowed to use/operate them.

The student must assume responsibility for following safe practices and rules, and therefore the student is asked to subscribe to the following safety pledge.

STUDENT'S SAFETY PLEDGE

1. "I (student) promise to follow all safety rules of the instructor/of the shop.
2. "I promise never to use a tool, machine, piece of equipment, or material of the vocational program without first having permission from the instructor.
3. "I will not ask permission to use a particular tool, machine, or piece of equipment unless I have been instructed in its use, and have made 100 percent on the safety test for that tool, machine or equipment.
4. "I will report any accident or injury to the vocational instructor immediately.
5. "I will report any potentially hazardious situation to the vocational instructor immediately."

Date __________ Student's Signature ____________________________

PARENT'S/GUARDIAN'S PERMISSION

"I hereby give my consent to allow my son/daughter to use/operate all occupational tools, machines, equipment, and materials necessary in carrying out the requirements of the vocational program of training."

Date __________ Parent's/Guardian's Signature __________________

(Parents are cordially invited to visit the shop to inspect the occupational tools, machines, and equipment and to see them in operation.)

BEST COPY AVAILABLE

METAL CUT/OFF SAW SAFETY

1. Always wear safety glasses or a face shield when operating the metal cut/off saw.

2. Use the correct type of abrasive cut/off blade for the type of material to be cut.

3. Make adjustments to the saw only when the saw is off.

4. Always shut off the saw before removing the metal from the saw after you have made the cut.

5. Stand to one side of the saw when operating it and make sure others are clear of the area before starting the saw.

6. Never operate the metal cut/off saw with fragile, non-reinforced abrasive blades.

7. The suggested capacity of the saw if 4 inch shapes and 2 inch solids.

8. Care should be exercised when holding materials against the fence by hand. Wear gloves to guard against heat and keep hands away from the blade.

9. When starting any abrasive cut/off saw, it is a good safety rule to allow the blade to operate at full speed for one minute before starting to cut.

10. Blades minimize in diameter as they are used. It is wise to save the full size blades for cutting pipe and larger shapes while consuming the worn blades on smaller sections.

11. Use the Cam/Clamp on the right or left of the fence. Avoid clamping against burrs.

12. When the Cam/Clamp is used:
    a. raise lever handle to an upright position
    b. place material in position, firmly against fence
    c. slide tab forward, firmly against material, securely tighten the "T" screw
    d. activate the Cam/Clamp by pulling the lever toward you

13. Pull blade into material firmly. Vary pressure when "loading" occurs.

14. The position of the material to be cut is important. Always try to maintain the minimum arc of contact between the blade and the material to be cut.

15. Always clean up when you are finished cutting metal and follow procedures for end of using machine.

LATHE SAFETY

1. Roll sleeves above elbows and remove or fasten any loose clothing.
2. Check to see that all guards are in place.
3. Be sure that all parts of the carriage will clear any rotating part during full length of cut.
4. Remove chuck key or wrench immediately after using.
5. Set tool on horizontal center of (or slightly above) work to be turned.
6. Wear eye protection devices.
7. Place your hands on the controls or at your sides except when filing or polishing.
8. Keep hands away from chips.
9. Cuts that are close to chuck or against a shoulder are to be finished by hand feed.
10. Bring lathe to a complete stop before reversing.
11. Move tool holder and tool post out of way before filing or polishing.
12. Between-Centers Turning Precautions:
    a. use lathe dog to drive work
    b. clamp tailstock securely
    c. adjust the tailstock center; lubricate if necessary
    d. regulate depth of cut according to size and type of metal
    e. use tools that are properly grounded for the particular job
13. Chuck and Faceplate Turning Precautions:
    a. place a board under chuck when threading the chuck on or off spindle, keep fingers clear
    b. secure work firmly in chuck
    c. remove chuck key or wrench immediately after using it
    d. counterbalance work on the faceplate if it is irregular in shape
    e. turn chuck or faceplate by hand through one complete cycle to make sure work is clear
    f. regulate depth of cut according to size and type of metal
    g. stand to one side of revolving faceplate
    h. stop power feed before tool reaches jaws of chuck

HEAT TREATING SAFETY

1. Heat treating involves metal heated to very high temperatures. Hot metal must be handled with appropriate care and tools.

2. Wear goggles and proper protective clothing, gloves, and apron.

3. Never look at the flames in a furnace unless you are wearing tinted goggles.*

4. Do not try to light a furnace until you have been instructed in its operations. Ask for instruction if you are not familiar with operation.*

   *Alternate heat treating methods may be employed where furnaces are not available.

5. Be sure area is properly ventilated.

6. Do not use potassium cyanide as a case-hardening medium.

7. Do not stand over the quenching bath when immersing work.

GRINDER SAFETY

1. Set tool rest 1/16 inch to 1/8 inch from wheel and spark tongue 1/4 inch from wheel.
2. Dress wheel when necessary.
3. Check that guards are in place.
4. Stand to one side of wheel.
5. Hold work with your hands. Ask instructor for permission to grind small pieces.
6. Use the face of the wheel only.
7. Press material against wheel with just sufficient pressure to cause steady, even removal of metal.
8. Keep work in motion across face of wheel.

BANDSAW SAFETY

1. The saw guide must be within one-half inch of the stock to be cut before power is turned on.

2. Do not allow fingers to come closer than 2 inches from the saw blade when cutting stock.

3. Do not permit hands to cross the saw line while operating the bandsaw.

4. Do not stand on the right side of the bandsaw while it is being used.

5. Cylindrical shock must not be cut on the bandsaw without the use of V-blocks.

6. The guide must not be adjusted while the machine is in operation.

7. Do not cut stock unless it is supported against the downward thrust of the saw.

8. If the bandsaw blade should break while the machine is in operation, immediately shut off the power, keeping clear of the saw, and notify the instructor at once.

9. Do not reach around the bandsaw blade to remove work.

10. Do not overcrowd the bandsaw.

11. Clean off the bandsaw and the floor around the bandsaw when through using the machine.

SAFETY WITH
HORIZONTAL BANDSAW OR POWER HACKSAW

1. Always wear safety glasses.
2. Never wear loose fitting clothing when using a power hacksaw.
3. Keep all guards and safety devices in good working order and in place.
4. Make all adjustments with the power off.
5. Keep floor clear of grease, oil, and short pieces of metal at all times.
6. Never clean chips from the saw while it is running.
7. Never clean chips from the machine with the hands...use a brush.
8. Handle cut pieces carefully, because they contain burrs which can cause serious cuts.
9. When shutting off the hacksaw, wait until the blade stops completely before leaving the area.
10. Always clamp the work securely in the saw vice.
11. Before starting the saw, be sure the blade is up out of contact with the work. After the blade is in motion, let it down gently onto the work, holding up on the handle slightly to reduce the pressure while the blade is starting its cut.
12. Clamp angle iron with the ridge up. Two or more may be cut at the same time by nesting them.
13. Make sure the teeth of the blade are pointing in the direction of the cut.
14. Do not push down on the saw to add pressure to the blade. The teeth can cut only as fast as their size will permit.
15. Use water soluble cutting oil when cutting with the power hacksaw.

TOOL AND DIE CUTTING MACHINE SAFETY

1. Attach plastic or metal pieces securely to the table.
2. Move milling cutters at a rate suited to the material being machined.
3. Operate the air controls with low pressure (2 lbs.).

USING THE LATHE SAFELY

1. Do not wear loose sleeves or neckties while operating the lathe.
2. Examine stock intended for turning for defects before placing it in lathe.
3. Securely lock in stock before lathe is started.
4. Check stock by hand to be sure it will clear tool rest.
5. Hold tools firmly as taught while turning stock.
6. Take care to prevent turning tools from catching in turning stock.
7. Before using caliper, stop late.
8. Tool rest must be kept proper distance from stock and must be centered just above stock to be turned. Tool rest should not be adjusted when lathe is operating.
9. Large diameter stock should not be turned at high speed.
10. Avoid burning lathe tools by taking too heavy a cut or scraping too long on a surface.
11. Use only proper metal working tools designed for lathe work.
12. Keep lathe tools sharp.
13. Keep lathe tool in rack when not being used.
14. Never put your hand on revolving stock.
15. Wear goggles or face shield when operating lathe.
16. Stand to one side when turning power on.
17. Clean off lathe when finished using it.
18. Observe all safety rules and procedures outlined by the instructor and manufacturer.

SURFACE GRINDER SAFETY

1. Secure work firmly in machine.
2. Select correct wrenches, hold downs, clamps, etc., for machine and work.
3. Run table and work through complete cycle of process by hand before turning on power feed.
4. Keep hands away from moving parts while automatic feed is engaged.

METALWORK SHAPER SAFETY

1. Use soft hammer or mallet to set work on the parallels.
2. Secure work firmly in the machine.
3. Select prescribed tool for the job.
4. Set machine for indicated depth of cut.
5. Be sure that ram and head will clear your work and any holding device.
6. Check to see that starting level is in neutral position before starting motor.
7. Stand to one side of machine when starting.

METALWORK PLANER SAFETY

1. Secure work firmly in the machine.
2. Select prescribed tool for the job.
3. Set machine for indicated depth of cut.
4. Make sure that work clears cross rail and sides of machine.
5. See that stops are set for controlling the movement of table.
6. Check to see that starting lever is in neutral position before starting the motor.
7. Keep your hands away from cutting tool and line of travel of moving parts of machine.

THERMOFORMING (PLASTIC) SAFETY

1. Wear eye protection.
2. Check thickness of plastic and adjust frame for thickness.
3. Turn on heating unit and keep hands from heated surfaces to avoid burns.
4. Regulate pressures/machine to specifications provided by instructor.
5. Observe safe operation of machine clamps, heat, etc.
6. Keep hands from heated plastic until properly cooled.
7. Use safety air nozzle to cool plastic and be careful to direct air only on the plastic.

MILLING MACHINE SAFETY

1. Do not attempt to operate the milling machine until you are thoroughly familiar with it. When in doubt, secure additional instructions.
2. Wear appropriate clothing for safety.
3. Get help to move any heavy attachment like the vise, dividing head, rotary table, etc.
4. Use a small brush to remove chips. Do not brush metal scraps with your hand.
5. Stop the machine before attempting to remove chips.
6. Never reach over or near the rotating center.
7. Make sure the holding device is mounted solidly to the blade, and the work held firmly. Spring or vibrating can cause thin cutters like the sitting saw to jam and shatter.
8. Do not talk to anyone while operating the machine.
9. Do not allow anyone to turn on your machine for you.
10. Be thoroughly familiar with the STOP level.
11. Treat any small cuts and skin punctures as potential infections. Clean them thoroughly, apply antiseptic and cover the injury as appropriate. Report any injury, even minor ones, to the instructor.
12. Keep the floor around the machine clear of chips and wipe up spilled cutting fluid immediately.
13. Do not permit work clothes to become saturated with cutting fluids or oil. Clean work clothes on a regular basis to prevent fire hazards.
14. Put all oily rages used to wipe down the machine in a metal container that can be closed tightly.

POLISHING/BUFFING SAFETY

1. Wear eye protection.
2. Hold work securely using both hands.
3. Ask instructor for special permission to buff small pieces.
4. Apply compound sparingly.
5. Keep hands away from the buffing wheel while it is in motion.
6. Hold work below center (horizontal axis) as wheel revolves toward you.
7. Buff flat surfaces from center toward lower edge. Sharp edges should point downward.
8. Press material against wheel with only sufficient pressure to cause wheel to polish the material.
9. Turn off power after using buffer.

DRILL PRESS SAFETY

1. Wear eyeshields while operating the drill press.
2. Clamp shall work in the vise or fasten it to the table.
3. Remove chips and shavings with a brush not with the hands. Stop the drill press before cleaning the table.
4. Keep fingers away from moving parts.
5. Keep hair, gloves, and loose clothing away from all moving parts.
6. Be sure that keys, drifts, and wrenches are all removed before starting the drill press.
7. Make certain bits are firmly clamped to prevent the chuck from becoming disengaged.
8. Holes to be drilled must be clearly marked.
9. Use a "V-block" for round or irregular shaped stock.
10. The only adjustment that can be made on the drill press while it is running is the speed adjustment.
11. Remove tie, rings, and wrist watch before using the drill press.
12. Keep the floor around the machine clear of scraps and material.
13. Be sure there is no oil on the floor around the drill press.
14. Be sure the power is off before you leave the machine.
15. Set up the work so you will not damage the vise or table by drilling into them.
16. Use only sharp bits or the proper accessories with the drill press.
17. Clean the table and the floor around the machine when you are through using it.
18. Never talk to the operator of a drill press in use.

UNIT 1.0 C

INTRODUCTION TO LEADERSHIP/ JOB COMMUNICATIONS

UNIT 1.0 C INTRODUCTION TO LEADERSHIP

TASK 1.01 WORK COOPERATIVELY WITH FELLOW STUDENTS

PERFORMANCE OBJECTIVE:

Given instruction and an opportunity to meet fellow students in the vocational program environment, work cooperatively with fellow students as well as with other students in related vocational learning activities. Meet the instructor's standards and cooperate to the satisfaction of fellow students as a group.

PERFORMANCE ACTIONS:

1.0101 Participate in class and group learning activities.

1.0102 Encourage team work.

1.0103 Help plan student activities that promote cooperation.

PERFORMANCE STANDARDS:

- Work cooperatively with fellow students to the standards of the instructor and to the standards expected by fellow students as a group.

SUGGESTED INSTRUCTION TIME: N/A (Integrated training)

UNIT	1.0 C	INTRODUCTION TO LEADERSHIP
TASK	1.02	DEMONSTRATE DESIRABLE CHARACTERISTICS OF LEADERSHIP

PERFORMANCE OBJECTIVE:

Given an introduction/orientation to desirable qualities of a good leader, describe characteristics typical of a good leader, discuss desirable leadership qualities, and demonstrate an ability to follow as well as take a leadership position. Performance should be satisfactory to the instructor and fellow students.

PERFORMANCE ACTIONS:

1.0201 Define (process of) leadership and why it is desirable in a job situation.

1.0202 Describe (minimum of five)* positive characteristics desirable in a good leader (based on instruction).

1.0203 Identify (three) basic steps to becoming a good leader.

1.0204 Identify (five) benefits from developing good leadership qualities.

1.0205 Demonstrate leadership qualities by participating as a fellow or member of a group and, if required, participating as a group leader.

*Standards of instructor apply.

PERFORMANCE STANDARDS:

- Participate as a contributing member of a group, such as the vocational class or VICA, and demonstrate desirable leadership qualities as outlined by the vocational program instructor.

SUGGESTED INSTRUCTION TIME: N/A

UNIT 1.0 C INTRODUCTION TO LEADERSHIP

TASK 1.02 DEMONSTRATE DESIRABLE CHARACTERISTICS OF LEADERSHIP (Con't.)

RELATED TECHNICAL INFORMATION:

- VICA Objectives.
- State Department of Education, District, and instructor supplied materials.

(NOTE: A student self-rating checklist may be used in evaluation may include ratings by other students as well as by the instructor.)

Addendum to Task 1.02 C

LEADERSHIP RATING SCALE

DIRECTIONS: Check the appropriate parenthesis to indicate your impression of the leadership characteristics being rated.

		Not Observed	Needs Improvement	Observed
1.	Exerts positive leadership.	( )	( )	( )
2.	Thoughful of feelings of others.	( )	( )	( )
3.	Enthusiasm is sincere and contagious.	( )	( )	( )
4.	Perserves until job is completed.	( )	( )	( )
5.	Cheerful disposition.	( )	( )	( )
6.	Gets along well with team members.	( )	( )	( )
7.	Gets along well with instructor/ supervisor.	( )	( )	( )
8.	Reacts constructively to criticism.	( )	( )	( )
9.	Punctual and gets job assignment done on time.	( )	( )	( )
10.	Free from prejudice.	( )	( )	( )
11.	Enjoys being a part of a group.	( )	( )	( )
12.	Reliable.	( )	( )	( )
13.	Adaptive to most situations.	( )	( )	( )
14.	Not easily discouraged.	( )	( )	( )
15.	Applies self to problems of job assignment.	( )	( )	( )
16.	Admits mistakes when made.	( )	( )	( )
17.	Tries to understand the other fellow's point of view.	( )	( )	( )
18.	Makes decisions quickly and accurately.	( )	( )	( )
19.	Seeks advise of others when appropriate.	( )	( )	( )
20.	Looks for opportunities to make improvements in job or work assignments.	( )	( )	( )

UNIT 1.0 C INTRODUCTION TO LEADERSHIP

TASK 1.03 (Optional) PARTICIPATE IN VICA CLUB ACTIVITIES*

PERFORMANCE OBJECTIVE:

Given an introduction/orientation to the Vocational Industrial Club of American (VICA)*, describe the general purposes of VICA, describe a typical VICA program at a vocational center, recall from memory the VICA motto, state the VICA pledge from memory, identify the symbols/symbolism in the VICA emblem, identify what the colors of the VICA organization represent. Performance should be acceptable to the VICA Club sponsor, instructor, and VICA Club members.

*Or a alternate, approved student organization.

PERFORMANCE ACTIONS:

1.0301 Join the VICA Club sponsored by the Career Center and vocational program.

1.0302 Participate actively as a member or an officer in the local VICA Club.

1.0303 Describe the purpose of VICA.

1.0304 Recall from memory the VICA motto.

1.0305 State the VICA pledge from memory.

1.0306 Name a minimum of five beliefs the VICA creed emphasizes.

PERFORMANCE STANDARDS:

- Demonstrate orally or in writing, from memory, accurate recall of the VICA motto, pledge, and at least five of the six beliefs of the VICA creed, and describe the purpose of VICA to the satisfaction of the VICA sponsor or VICA Club officers and members as well as to the satisfaction of the vocational program instructor.

SUGGESTED INSTRUCTION TIME: N/A

UNIT 1.0 C INTRODUCTION TO LEADERSHIP

TASK 1.03 (Optional) PARTICIPATE IN VICA CLUB ACTIVITIES* (Con't.)

RELATED TECHNICAL INFORMATION:

- VICA publication(s).
- VICA emblem.
- VICA motto, pledge, and creed.
- Local VICA Club in Career Center.

UNIT 1.0 C JOB COMMUNICATIONS

TASK 1.04 (Optional) DEMONSTRATE PROPER USE OF PARLIAMENTARY PROCEDURE

PERFORMANCE OBJECTIVE:

Given instruction, apply the principles of parliamentary procedure and describe the characteristics of a good chairman.

PERFORMANCE ACTIONS:

1. Identify two basic principles upon which parliamentary procedure is based.
2. List two important characteristics of a "good" chairman.
3. Define or identify types of motions.
4. Describe/identify the order of business for a meeting conducted by parliamentary procedure.
5. Describe/identify the characteristics of the kinds of motions used in conducting a typical meeting by parliamentary procedure.
6. Demonstrate ability to use parliamentary procedure correctly.

PERFORMANCE STANDARDS:

- Define parliamentary procedure and how it is used to contribute to a meeting, identify the characteristics of a good chairman, and used parliamentary procedures correctly meeting the standards of the instructor.

SUGGESTED INSTRUCTION TIME: N/A

(NOTE: "This activity should be integrated into VICA activities and objectives.")

RELATED TECHNICAL INFORMATION:

- Robert's Rules of Order.
- VICA Club.
- Public Speaking.

UNIT 1.0 C JOB COMMUNICATIONS

TASK 1.05 (Optional) COMMUNICATE A MESSAGE BY THE MEDIUM OF A SPEECH

PERFORMANCE OBJECTIVE:

Given instruction, list purposes of a speech, characteristics of a speech, and write and orally deliver a speech. The delivered speech should contain accurate information, be technically correct in organization and delivery, and the intended message should be communicated.

PERFORMANCE ACTIONS:

1. Identify three purposes for making a speech.
2. Write an outline for a proposed speech.
3. List at least five methods/ways to make a speech effective/interesting.
4. Deliver a three to five minute speech that successfully communicates the intended message.

PERFORMANCE STANDARDS:

- Successfully communicate intended message by a speech using proper techniques and meeting instructor's (or VICA sponsor's) standards.

ALTERNATE STANDARD:

- Student is to describe verbally, task being performed, techniques used, etc., to the instructor's standards.

SUGGESTED INSTRUCTION TIME: N/A

(NOTE: "This activity may be integrated into VICA activities and objectives.")

RELATED TECHNICAL INFORMATION:

- VICA Club.
- Communications.

UNIT 1.0 D

PREPARING FOR WORK

UNIT 1.0 D PREPARING FOR WORK

TASK 1.01 DESCRIBE THE FREE ENTERPRISE SYSTEM AND THE DIFFERENCE BETWEEN LABOR AND MANAGEMENT

PERFORMANCE OBJECTIVE:

Given an introduction/orientation to the free enterprise system of economics, describe to the satisfaction of the instructor the free enterprise system of economics as found in the United States and describe the relationship between labor and management.

PERFORMANCE ACTIONS:

1.0101 Read assignments in trade magazines or periodicals.

1.0102 Listen to talks by representatives of labor and management.

1.0103 Discuss the Free Enterprise System as represented by business/industry in the United States.

1.0104 Discuss problems concerning employee management-trade union transactions.

PERFORMANCE STANDARDS:

- To the satisfaction of the instructor describe the Free Enterprise System of economics as represented by business/-industry in the United States.

SUGGESTED INSTRUCTION TIME: N/A

RELATED TECHNICAL INFORMATION:

- Free Enterprise System of Economics.
- Management and Labor Relationships.

UNIT 1.0 D PREPARING FOR WORK

TASK 1.02 INTERPRET LABOR LAWS AND REGULATIONS

PERFORMANCE OBJECTIVES:

Given instruction, necessary references concerning labor laws and regulations, interpret typical labor laws and regulations. Performance must meet the instructor's standards.

PERFORMANCE ACTIONS:

1.0201 Identify and interpret the "Fair Labor Standards Act."

1.0202 State the minimum wage for a worker.

1.0203 State the typical minimum age for a worker.

1.0204 Define overtime.

1.0205 Identify local or State laws that affect the worker.

PERFORMANCE STANDARDS:

- Interpret typical labor laws and regulations of the Federal, State, and local level that affect the worker.
- The instructor's standards must be met.

SUGGESTED INSTRUCTION TIME: N/A

UNIT 1.0 D PREPARING FOR WORK

TASK 1.03 INTERPRET PAYROLL DEDUCTIONS FOR TAXES, ETC.

PERFORMANCE OBJECTIVE:

Given instruction and sample forms concerning income tax and other withholdings, interpret the typical forms used in income tax and other withholdings to the satisfaction of the instructor and itemize typical payroll deductions that worker encounters. Performance must be to the instructor's standards.

PERFORMANCE ACTIONS:

1.0301 Obtain a social security card (if not acquired already). [Recommended]

1.0302 Identify the purposes of social security withholdings from pay.

1.0303 Describe who is qualified for unemployment compensation.

1.0304 Describe who qualifies for workmen's compensation.

1.0305 Complete typical forms used for Federal Income Tax Withholdings.

1.0306 Interpret a typical Federal Income Tax Wage and Tax Statement form.

1.0307 Identify typical payroll deductions.

PERFORMANCE STANDARDS:

- Given typical forms used for payroll deduction and reporting of income and other taxes, interpret payroll deductions and other statements on the forms.
- Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: N/A

UNIT 1.0 D PREPARING FOR WORK

TASK 1.04 IDENTIFY TYPICAL CAREER OPPORTUNITIES

PERFORMANCE OBJECTIVE:

Given instruction, data on the local business and industry, opportunities to study entry-level job opportunities; identify the major categories of potential employers in the local community (and the key characteristics of each).

PERFORMANCE ACTIONS:

"Performance actions may vary from career center to career center due to the potential employers served and based on the emphasis of the individual vocational program."

PERFORMANCE STANDARDS:

- Identify typical types of entry-level jobs, in the local community, and the major characteristics that distinguish them based on given instruction, local market data, and student observation.
- Meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT	1.0 D	PREPARING FOR WORK
TASK	1.05	LOCATE JOB OPPORTUNITIES

PERFORMANCE OBJECTIVE:

Given job placement information such as newspaper ads and personal contacts, list a minimum of ten specific jobs in the community. One week will be allowed to complete the task.

PERFORMANCE ACTIONS:

1.0501 Identify job opportunity areas as related to training, skills, and interests.

1.0502 Contact (or list) various employment opportunity sources:

a. Job placement office.
b. Want ads.
c. Employment Security.
d. Other sources such as family, friends, school officials, etc.

1.0503 Estimate competition for job opportunities (number of other persons wanting same job) and target enough job opportunities to statistically qualify for one opportunity.

PERFORMANCE STANDARDS:

- Student must list a minimum of ten specific jobs in the community ad advertised in the newspaper or media or through personal contacts.
- The jobs must be available currently.

SUGGESTED INSTRUCTION TIME: * (Integrated)

UNIT 1.0 D PREPARING FOR WORK

TASK 1.06 (Optional) PREPARE RESUME

PERFORMANCE OBJECTIVE:

Given examples of suitable resume/personal data sheets, prepare and type (or print at a minimum) a personal resume on paper acceptable to the instructor with all errors acceptable corrected.

PERFORMANCE ACTIONS:

1.0601 Define the basic purpose of the resume.

1.0602 Outline the essential information a resume of personal data sheet should contain:

a. Personal data such as name, address, telephone, age, physical descriptions, marital status, etc.
b. Job objective or skills offered.
c. Training.
d. Experience.
e. Accomplishments, interests, etc.
f. References.

1.0603 Prepare a resume that is acceptable to the instructor.

PERFORMANCE STANDARDS:

- Prepare resume/personal data sheets on paper and in a form acceptable to the instructor with all errors acceptable corrected.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Job Seeking - How and Where, Columbia, SC: South Carolina State Department of Education, 1981.

UNIT 1.0 D PREPARING FOR WORK

TASK 1.07 COMPOSE APPLICATION LETTER

PERFORMANCE OBJECTIVE:

Given a newspaper ad for a job, compose a letter of application. The letter must be mailable and must include all necessary personal information.

PERFORMANCE ACTIONS:

1.0701 Assemble necessary information, supplies, and equipment.

1.0702 Compose a letter of application for a given business position. Include the necessary information.

1.0703 Proofread the letter, correcting all errors.

PERFORMANCE STANDARDS:

- Compose a letter of application for a position advertised in the local newspaper and suitable for the skills and experience of the student or for the hypothetical position described by the instructor.
- Include necessary personal information and prepare the letter in mailable form.

SUGGESTED INSTRUCTION TIME: Optional

RELATED TECHNICAL INFORMATION:

- Job Seeking - How and Where, Columbia, SC: South Carolina State Department of Education, 1981.

UNIT	1.0 D	PREPARING FOR WORK
TASK	1.08	COMPLETE A TYPICAL EMPLOYMENT APPLICATION FORM

PERFORMANCE OBJECTIVE:

Given an employment application form typical of the job, complete the form with all information accurate, neatly typed or printed in, and aligned in the form blanks.

PERFORMANCE ACTIONS:

1.0801 Assemble minimum necessary information:

- a. Personal information such as name, address, and date of birth.
- b. Data related to applicant such as social security number, etc.
- c. Schooling or training information.
- d. Past employment record.
- e. References.

1.0802 Complete the application form following directions carefully with neat, aligned entries.

1.0803 Proofread the completed form for errors or incomplete blanks.

PERFORMANCE STANDARDS:

- Complete an employment application form typical of the job with all information accurate, neatly printed or typed in and aligned in the form blanks to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Job Seeking - How and Where, Columbia, SC: South Carolina State Department of Education, 1981.

UNIT 1.0 D PREPARING FOR WORK

TASK 1.09 INTERVIEW FOR A JOB

PERFORMANCE OBJECTIVE:

Given instruction on how to interview for a job, a job interview checklist, and a mock job interview; complete a job interview to the satisfaction of the instructor.

PERFORMANCE ACTIONS:

1.0901 Prepare for the interview:

- a. Prepare personal appearance.
- b. Prepare necessary information, references, or other material for the interview.

1.0902 Arrive at the appropriate time and identify yourself and your purpose or appointment.

1.0903 Give a good impression in meeting the interviewer.

1.0904 Exchange essential information with the interviewer to reflect your job skills, training, and experience as well as your personality. In addition, learn about the job opportunity and employer.

PERFORMANCE STANDARDS:

- Complete a mock job interview to the satisfaction of the instructor following suggested procedures.

SUGGESTED INSTRUCTION TIME: 3 Hours

UNIT 1.0 D PREPARING FOR WORK

TASK 1.10 (Optional) COMPOSE FOLLOW-UP LETTER

PERFORMANCE OBJECTIVE:

Given a case situation by the instructor or from the textbook, compose and write a follow-up letter appropriate to the job application or interview situation and in mailable form. The finished letter must meet the instructor's standards.

PERFORMANCE ACTIONS:

1.1001 Assemble necessary information, supplies, and equipment.

1.1002 Compose a follow-up letter, in mailable form, to a given job application or interview situation.

1.1003 Proofread the letter, correcting all errors.

PERFORMANCE STANDARDS:

- Compose and write a follow-up letter appropriate in the judgement of the instructor to a given job application or interview situation and in mailable form.

SUGGESTED INSTRUCTION TIME: Optional

RELATED TECHNICAL INFORMATION:

- Job Seeking - How and Where, Columbia, SC: South Carolina State Department of Education, 1981.

UNIT 1.0 D PREPARING FOR WORK

TASK 1.11 IDENTIFY POST-SECONDARY CAREER DEVELOPMENT OPPORTUNITIES

PERFORMANCE OBJECTIVE:

Given an orientation to similar post-secondary career development programs, such as offered at Greenville Technical College, a report of skill competencies developed during secondary training, and other information as needed; identify post-secondary career development opportunities.

PERFORMANCE ACTIONS:

1.1101 Identify:

- a. Need for additional training at the post-secondary level.
- b. Benefits from additional training.

1.1102
- a. Identify post-secondary training programs available at GTC.
- b. Identify how post-secondary (GTC) training differs from secondary training in related areas.

1.1103 Visit GTC program of possible interest. Talk with instructor, department head, or admissions counselor at GTC.

1.1104 Determine, with secondary and post-secondary personnel assistance, if exemption of post-secondary level training is recommended.

1.1105 Accomplish the required steps to apply or test for exemptions (if applicable).

PERFORMANCE STANDARDS:

- Identify post-secondary training opportunities, specifically at GTC, to include: Associate Degree or Diploma in area of possible career interest.

SUGGESTED INSTRUCTION TIME: 6 Hours Approximately

UNIT 1.0 E

INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/HABITS/ATTITUDES

UNIT 1.0 E INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS HABITS/ATTITUDES

TASK 1.01 DESCRIBE GOOD WORK HABITS IMPORTANT TO JOB SUCCESS

PERFORMANCE OBJECTIVE:

Given introduction/orientation to desirable work habits, as described by potential employers or tradesmen, demonstrate desirable (good) work habits (based on information provided by the instructor) that represent typical standards expected by business/industry (potential employers) for entry employment success.

PERFORMANCE ACTIONS:

1.0101 Identify specific criteria for success in typical entry level job categories.

1.0102 Participate in planning student's learning activities.

1.0103 Maintain a clean, well-organized learning situation (desk, locker, work area, shop, etc.) which is conducive to effective learning.

1.0104 Objectively receive instructor or other critique (correction, criticism, suggestions, etc.) of learning or job performance (behavior) or product or activity.

1.0105 Describe good work habits and how they are related to job success, stability, and advancement.

PERFORMANCE STANDARDS:

- Describe to the instructor's standards good work habits that are important to job success, stability, and advancement.

SUGGESTED INSTRUCTION TIME: N/A

UNIT 1.0 E INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/ HABITS/ATTITUDES

TASK 1.02 EXHIBIT SUCCESSFUL JOB PERFORMANCE CHARACTERISTICS

PERFORMANCE OBJECTIVE:

Given instruction, demonstrate job performance characteristics that are considered important to entry-level career success in the vocational field. A "Job Performance Rating Sheet" will be used to evaluate performance and all items must be rated "frequently" or above.

(NOTE: It is recommended in research findings that employer-recommended "job performance characteristics" and "work attitudes" be included as part of the vocational student's overall training and that demonstrated performance in these areas be included in the total evaluation of the student.)

PERFORMANCE ACTIONS:

1.0201 Review important work characteristics for the vocational field.

1.0202 Review the "Job Performance Rating Sheet" with the instructor.

1.0203 Demonstrate those work characteristics that are considered important to success in the vocational field.

PERFORMANCE STANDARDS:

- Demonstrate by personal performance the work characteristics that are considered important.
- A "Rating Sheet" will be used to evaluate performance and all items must be rated "frequently" (observed) or above.

SUGGESTED INSTRUCTION TIME: 3 Hours

Accompanied by addendum page (Rating Sheet)

Rating sheet may include the following categories:

- Accuracy of work.
- Care of working space.
- Care of equipment.

UNIT	1.0 E	INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/ HABITS/ATTITUDES
TASK	1.02	EXHIBIT SUCCESSFUL JOB PERFORMANCE CHARACTERISTICS

Rating Sheet (Con't.):

- Speed
- Use of working time
- Initiative
- Attendance
- Attitude toward fellow workers
- Attitude toward teacher
- Observance of safety rules
- Use of materials
- Responsibility
- Accident report
- Personal appearance, cleanliness

Addendum to Task 1.02 E

JOB PERFORMANCE RATING SHEET

Student ______________________ Job Performed ______________

Dates from ____________________ to ________________________

Place of work _________________ Supervisor ________________

DIRECTIONS: Circle the number that best fits your opinion of the student's performance using the following factors:

		Never	Seldom	Frequently	Usually	Always
1.	Gets to work on time	1	2	3	4	5
2.	Uses time properly	1	2	3	4	5
3.	Shows interest in work	1	2	3	4	5
4.	Shows dependability	1	2	3	4	5
5.	Is ambitious	1	2	3	4	5
6.	Is neat (work and self)	1	2	3	4	5
7.	Works well with others	1	2	3	4	5
8.	Follows directions	1	2	3	4	5
9.	Works without supervision	1	2	3	4	5
10.	Shows good manners	1	2	3	4	5
11.	Meets people well	1	2	3	4	5
12.	Uses knowledge on the job	1	2	3	4	5
13.	Seeks assistance, when necessary	1	2	3	4	5

Does the worker have the skills for doing satisfactory work?
Yes __ No __

List the skills or characteristics that need to be developed or improved upon:

Additional comments:

Date ____________________ Supervisor ______________________

UNIT 1.0 E INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/HABITS/ATTITUDES

TASK 1.03 EXHIBIT DESIRABLE WORK ATTITUDES

PERFORMANCE OBJECTIVE:

Given instruction, demonstrate work attitudes that the majority of potential employers prefer in an entry level worker. Performance will be evaluated on a "Work Attitudes Score Sheet" and a minimum of 90 percent should be attained. Performance will be rated throughout training and should improve to 100 percent by the end of the training period.*

PERFORMANCE ACTIONS:

1.0301 Review work attitudes considered important to success in the vocational field.

1.0302 Review the "Work Attitudes Score Sheet."

1.0303 Demonstrate the type of work attitudes that potential employers in the local industry report as important to job success.

PERFORMANCE STANDARDS:

- Demonstrate to 90 percent acceptable rating on a "Work Attitudes Score Sheet" to be completed by the instructor those work attitudes considered important by local potential employers for entry-level job success.

SUGGESTED INSTRUCTION TIME: 3 Hours

Accompanied by addendum page: (Work Attitudes Score Sheet)

(*NOTE: It is recommended in research study findings that employer-recommended "job performance characteristics" and "work attitudes" be included as part of the vocational student's overall training and that demonstrated performance in these areas be included in the total evaluation of the student.)

Addendum to Task 1.03 E

WORK ATTITUDES SCORE SHEET

DIRECTIONS: Score the student on the following attitudes and work behavior by circling the appropriate description either "yes" (+) or "no" (-). Indicate any comments to support the rating or recommendations.

	Circle (No)	Circle (Yes)	Comments/ Recommendations
Cooperative	-	+	
Courteous	-	+	
Loyal to program study and job team members	-	+	
Tackful	-	+	
Self Disciplined	-	+	
Respectful	-	+	
Alert	-	+	
Motivated	-	+	
Responsible	-	+	
Trustworthy	-	+	
Dependable	-	+	
Cheerful	-	+	
Polite	-	+	
Interest	-	+	
Friendly	-	+	
Sympathetic (sensitive) to fellow students	-	+	
Accepts changes	-	+	
Follows rules and regulations	-	+	
Does share of work	-	+	
Helps others, if needed	-	+	
Works regularly	-	+	
On time	-	+	
Shows pride in work	-	+	
Keeps promises	-	+	
Does not waste time	-	+	
Controls anger	-	+	
Accepts criticism	-	+	
Follows superior's directions	-	+	

28 Items total TOTAL (+'s) ________

INTERPRETATION

28 = 100% = Level 4
25 = 90% = Level 3
22 = 80% = Level 2
20 = 70% = Level 1
17 = 60% = Level 0

Student: ______________________________

UNIT 1.0 E — INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/ HABITS/ATTITUDES

TASK 1.04 — DEMONSTRATE RESPECT FOR AND CARE OF SCHOOL PROPERTY

PERFORMANCE OBJECTIVE:

Given a classroom, shop, or other instructional setting with access to furniture, equipment, tools and materials, and given proper instruction; demonstrate a respect for and care of public property (training facilities) and instructional materials to the standards established by The School District of Greenville County, the career center, and the instructor.

PERFORMANCE ACTIONS:

1.0401 Listen to information provided by the instructor and read given or posted materials concerning student behavior and care of property.

1.0402 Demonstrate respect for and care of public school property including:

a. Facilities (building, classroom).
b. Furnishing (furniture).
c. Equipment and tools.
d. Instructural materials.

PERFORMANCE STANDARDS:

- Demonstrate respect for and care of school property as represented by the classroom, shop, equipment, tools and materials used in instruction.
- Performance must be to the standards of policies of the School District, the career center, and the instructor.

(NOTE: A willful disregard or disrespect (intentional damage or destruction) of instructional facilities, equipment, or materials should be considered a most serious situation since an employer typically would require payment for intended damages and might fire the employee or bring legal charges against the employee for intentional damage to facilities, equipment, or materials.)

SUGGESTED INSTRUCTION TIME: N/A Integrated during two-year training period.

UNIT 1.0 F

BASIC MATH SKILLS

UNIT 1.0 F BASIC MATH SKILLS

TASK 1.01 BASIC MATH - FRACTIONS

PERFORMANCE OBJECTIVE:

Given a pretest or examples by the instructor, conduct the following operations with fractions:

1. Change any fraction to a decimal number, and any terminating decimal number to a fraction.
2. Arrange in order...unit and simple nonunit fractions.
3. Write equivalent fractions in higher, lower, and lowest terms.
4. Write improper fractions as whole or mixed numbers, and mixed numbers as improper fractions.
5. Multiply fractions and mixed numbers, expressing answers in simplest form.
6. Divide fractions and mixed numbers, expressing answers in simplest form.
7. Add and subtract unlike fractions, expressing answers in simplest form.
8. Add and subtract mixed numbers with unlike fractions, expressing answers in simplest form.
9. Use rational numbers to solve simple work problems.

PERFORMANCE ACTIONS:

Consult: Curriculum Guide for High School General Mathematics, Greenville, SC: The School District of Greenville County, 1979.

PERFORMANCE STANDARDS:

- Student should be able to complete pretest in Math Curriculum Guide with 90 percent accuracy.
- Consult the Math Curriculum Guide for pretests, suggested exercises, and references.

(NOTE: The level of this math skill is eighth grade, General Math I.)

SUGGESTED INSTRUCTION TIME: 6 Hours (Actual hours of instruction will be determined by student's math skill as indicated by pretest. Remedial instruction may be at initiation of skill development if required.)

UNIT 1.0 F BASIC MATH SKILLS

TASK 1.02 BASIC MATH - DECIMALS

PERFORMANCE OBJECTIVE:

Given a pretest or examples by the instructor, conduct the following decimal math operations:

1. Name the place value of digits in decimal numbers of up to nine digits before the decimal and six digits after the decimal.
2. Compare decimal numbers and arrange them in order.
3. Write the numeral for any decimal number of up to four decimal places.
4. Round decimal numbers to any designated place value up to thousandths.
5. Add and subtract decimal numbers of up to six digits.
6. Multiply decimal numbers by whole numbers or decimal numbers.
7. Divide a number by a three-digit decimal number.
8. Multiply and divide decimal numbers by powers of ten, by inspection.

PERFORMANCE ACTIONS:

Consult: Curriculum Guide for High School General Mathematics, Greenville, SC: The School District of Greenville County, 1979.

PERFORMANCE STANDARDS:

- Student should be able to complete pretest in Math Curriculum Guide with 90 percent accuracy.
- Consult: Curriculum Guide for High School General Mathematics, 1979, for pretests, suggested exercises, and references.

SUGGESTED INSTRUCTION TIME: 6 Hours (Actual hours of instruction will be determined by the student's math skill as indicated by pretest. Remedial instruction may be at initiation of skill development if required.)

(NOTE: The level of this math skill is eighth grade, General Math I.)

UNIT 1.0 F BASIC MATH SKILLS

TASK 1.03 BASIC MATH - VOLUMES

PERFORMANCE OBJECTIVE:

Given a pretest or examples by the instructor, find the volume of any rectangular prism or cube.

PERFORMANCE ACTIONS:

Consult: Curriculum Guide for High School General Mathematics, Greenville, SC: The School District of Greenville County, 1979.

PERFORMANCE STANDARDS:

- Student should be able to complete pretest in Math Curriculum Guide with 90 percent accuracy.
- Consult: Math Curriculum Guide for pretests, suggested exercises, and references.

SUGGESTED INSTRUCTION TIME: 1 Hour (Actual hours of instruction will be determined by the student's math skills as indicated by pretest. Remedial instruction may be at initiation of skill development if required.)

(NOTE: The level of this math skill is eighth grade, General Math I.)

UNIT 1.0 F BASIC MATH SKILLS

TASK 1.04 BASIC MATH - AREAS

PERFORMANCE OBJECTIVE:

Given a pretest or examples by the instructor, find the area of the following types of figures:

a. Rectangle and square
b. Circle

PERFORMANCE ACTIONS:

Consult: Curriculum Guide for High School General Mathematics, Greenville, SC: The School District of Greenville County, 1979.

PERFORMANCE STANDARDS:

- Student should be able to complete pretest in Math Curriculum Guide with 90 percent accuracy.
- Consult the Math Curriculum Guide for pretests, suggested exercises, and references.

SUGGESTED INSTRUCTION TIME: 1 Hour (Actual hours of instruction will be determined by the student's math skill as indicated by pretest. Remedial instruction may be at initiation of skill development if required.)

(NOTE: The level of this math skill is eighth grade, General Math I.)

UNIT 1.0 F BASIC MATH SKILLS

TASK 1.05 (Optional) THE METRIC SYSTEM

PERFORMANCE OBJECTIVE:

Given basic instruction in the metric system and conversion from United States Customary units to metric; read and convert specifications and dimensions from one system into the other system on teacher or text assigned problems with 100 percent accuracy.

PERFORMANCE ACTIONS:

1.0501 Demonstrate ability to read and use U.S. Customary length measurements.

1.0502 Identify basic SI units and symbols.

UNIT	NAME	SYMBOL
Length	Meter	m
Electric Current	Ampere	A
Temperature	Kelvin	K

1.0503 Identify basic Metric prefixes:

PREFIX	AMOUNT	FRACTION	DECIMAL
Milli	One-thousandth	1/1000	0.001
Centi	One-hundredth	1/100	0.01

1.0504 Convert Inches to Millimeters
Inches x 25.4 = Millimeters

1.0505 Convert Millimeters to Inches
Millimeters x 0.0394 = Inches

PERFORMANCE STANDARDS:

- Accuracy of 100 percent in conversion of length from one system to the other system.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- ANSI Standards
- System International d'United (SI) (Metric System)
- U.S. Customary Measurements System

Addendum to Unit 1.0 F

MACHINE SHOP
MATH PERFORMANCE OBJECTIVES

The following math objectives for Machine Shop were identified in employer surveys conducted by the State Department of Education in 1976.[1]

1. Can identify common fractions.
2. Can identify decimal fractions.
3. Knows how to write numbers correctly by placing the decimal in the proper place.
4. Can reduce fractions to lowest terms.
5. Can change common fractions to decimal fractions.
6. Can change decimal fractions of one digit to fractions of two or more digits with the same value.
7. Can read and use settings from the table of decimal equivalents when measuring with the micrometer or vernier caliper.
8. Can convert feet and inches into feet and decimal fractions of a foot.
9. Can add decimals, keeping the decimals in the proper place.
10. Can subtract decimals, keeping decimal points in line when numbers of different values are used.
11. Can multiply decimals and place the decimal point in proper position.
12. Can divide decimals and place the decimal point in proper position.
13. Can find and use decimal equivalency charts in the Machinist's Handbook.
14. Can calculate taper per inch by using the formula: $\frac{\text{Taper/inch}}{12}$
15. Can calculate taper per foot using the formula: Taper/inch x 12
16. Can calculate tailstock setover using the formula:
    1/2 Total Length of Piece x Taper/inch
17. Can calculate RPM's using the proper formula.
18. Can calculate cutting speed in feet per minute using the proper formula.

19. Can calculate Feed rate for milling using the appropriate procedures.

20. Can calculate the cutting speed for a shaper.

21. Can calculate the number of strokers for a shaper.

22. Can calculate the compound rest angle to taper using the appropriate formula.

(NOTE: Additional math skills (tasks) which typically are learned as integrated actions of other first and second year tasks are summarized in the second year section of this articulated instruction guide in the unit "Machining Math Calculations.")

[1] Chastain, L. Joel, ed., Career Cluster Articulation Model Based on Behavioral Objectives, Columbia, SC: SC State Department of Education (Office of Vocational Education, Research Coordinating Unit), p. 163, 1976.

UNIT 1.0 G

BASIC MEASURING

UNIT 1.0 G BASIC MEASURING

TASK 1.01 MEASURING

PERFORMANCE OBJECTIVE:

Given proper instructions, read a rule and use other measuring tools with the precision necessary to take measurements from drawings, and transpose them to exact working lengths and angles.

PERFORMANCE ACTIONS:

1.0101 Define measuring terms with 80 percent accuracy.

1.0102 Accurately identify basic tools used in measuring.

1.0103 Read a rule to the nearest feet, inches, and fractions of inches down to 1/16 inch.

1.0104 Demonstrate ability to perform following measuring skills:

a. Measure objects to nearest sixteenth of an inch when given pictures of objects and a measuring instrument.
b. Draw lines and objects to specified dimensions.

PERFORMANCE STANDARDS:

- Demonstrate ability to measure to 1/16 inch and draw lines or objects to specified dimensions (1/16 inch accuracy).

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Graduations on rule: Halves, quarters, eights, sixteenths.
- Rules: Tapes (steel or other), following rule, straight rule, steel square.

UNIT 1.0 G BASIC MEASURING

TASK 1.01 MEASURING (Con't.)

DEFINITIONS

MEASURING	Setting of limits or bounds according to a pre-determined standard.
INCH	Smallest whole unit of lineal measure typically used.
FOOT	Unit of measure consisting of twelve equal parts called inches.
FRACTION	One or more equal parts of a whole. (i.e., 1/2 inch, 1/4 inch, 3/8 inch, and 5/16 inch)
RULE	Instrument graduated in whole units and fractions of units and used in measuring.
DIMENSION	Number of full units and fraction of units between two points.

UNIT 1.0 H

INTRODUCTORY BLUEPRINT READING - MACHINE SHOP

See the second year unit, Advanced Blueprint Reading in Machining, for additional task objectives concerning blueprint reading.

UNIT 1.0 H INTRODUCTORY BLUEPRINT READING

TASK 1.01 INTERPRET MULTIVIEW DRAWINGS

PERFORMANCE OBJECTIVE:

Given a selection of multiview blueprints or drawings (orthographic projections) complete with symbols, notations, dimensions, and tolerances, and the necessary reference materials; interpret the multiview drawings. All symbols, notations, dimensions, and tolerances must be identified. Side, top, and front views must be identified from each drawing.

PERFORMANCE ACTIONS:

1.0101 Define orthographic projection.

1.0102 Identify the six principal views in an orthographic projection.

1.0103 Explain how several views can be used to define the shape of an object or part completely.

1.0104 Explain how to read lines and areas in a multiview drawing.

1.0105 Describe the procedure for interpreting a multiview drawing.

1.0106 Make freehand sketches or parts in side, top, and front views using coordinate paper or plain paper with drawing/drafting equipment.

PERFORMANCE STANDARDS:

- Interpret multiview (orthographic projections) with all symbols, notations, dimensions, and tolerances identified and with the side, top, and front views identified. Performance must be to the standards established by the instructor.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify all parts of title block on blueprint.
- Alphabet of Lines.

UNIT 1.0 H INTRODUCTORY BLUEPRINT READING

TASK 1.02 DETERMINE DIMENSIONS AND TOLERANCES

PERFORMANCE OBJECTIVE:

Given a selection of machine shop blueprints or drawings, and the necessary reference and writing materials; determine the dimensions and tolerances given on the drawings using dimension lines, centerlines, projection lines, and views. Correct dimensions must be determined in order to machine the parts. Tolerances must be identified with 100 percent accuracy.

PERFORMANCE ACTIONS:

1.0201 Explain the purpose of dimensions and tolerances.

1.0202 Explain how fractions and decimal dimensions and tolerances are indicated on a blueprint.

1.0203 Describe the procedure to determine dimensions.

1.0204 Explain why blueprints and drawings are drawn to scale.

1.0205 Make freehand sketches and apply dimensions and tolerances to the sketches.

PERFORMANCE STANDARDS:

- Determine correct dimensions and tolerances from given machine shop blueprints and drawings accompanied by the necessary reference materials, with an accuracy of 100 percent.

SUGGESTED INSTRUCTION TIME: 12 Hours

UNIT	1.0 H	INTRODUCTORY BLUEPRINT READING
TASK	1.03	INTERPRET PICTORIAL DRAWINGS

PERFORMANCE OBJECTIVE:

Given a selection of pictorial drawings complete with symbols, notations, dimensions, and tolerances, and the necessary reference materials; interpret the pictorial drawings. All symbols, notations, dimensions, and tolerances must be identified.

PERFORMANCE ACTIONS:

1.0301 Identify the following types of pictorial drawings:

- a. Isometric
- b. Oblique
- c. Perspective

1.0302 Explain the difference between pictorial drawings and orthographic projections.

1.0303 Describe the procedure for interpreting a pictorial drawing.

1.0304 Make freehand sketches of parts in isometric, oblique, and perspective.

PERFORMANCE STANDARDS:

- Interpret pictorial drawings identifying all symbols, notations, dimensions, and tolerances.

SUGGESTED INSTRUCTION TIME: 3 Hours

UNIT 1.0 I

WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

The purpose of these tasks is to develop basic knowledges and skills essential to success as a machinist.

Emphasis will be on effectively and efficiently sending and receiving technical messages concerning machining operations.

UNIT 1.0 I WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

TASK 1.01 WRITE TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

PERFORMANCE OBJECTIVE:

Given instruction and an introduction to the secondary machine shop program and the terminology of the trade, write technical reports/ communications that convey the intended messages and that can be read intelligently by another machinist student (or machinist). Student performance must be acceptable to the instructor.

The written message may include notations, etc., made on working drawings, specifications, technical instruction, or descriptions of machining operations using the proper terminology. The message intended must be communicated to the receiver.

While correct spelling and punctuation is desirable, emphasis will be on effective and efficient communications of a technical message.

PERFORMANCE ACTIONS:

1.0101 Interpret technical terminology commonly used in machining as identified by the instructor.

1.0102 Write technical notations, instructions, and machining descriptions that communicate the intended message to another machinist student, to the instructor, or to a machinist.

PERFORMANCE STANDARDS:

- Write technical information concerning machine operations, etc., that communicates the intended message.
- Instructor's standards apply.

SUGGESTED INSTRUCTION TIME: 3 Hours (Training integrated into all units.)

RELATED TECHNICAL INFORMATION:

- Technical terminology of machine shop trade.

UNIT 1.0 I WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

TASK 1.02 READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS

PERFORMANCE OBJECTIVE:

Given an introduction to the secondary machine shop program and the terminology used in the trade, read and interpret technical literature or information concerning machining operations. Reading competency should be demonstrated by the ability to read and interpret information from blueprints and specifications, technical instructions, and manufacturer's manuals on equipment. Student performance must be acceptable to the instructor.

PERFORMANCE ACTIONS:

1.0201 Read and interpret common technical terms used in machine shop work as identified by the instructor.

(e.g., "set to zero," sine bar, tailstock, micro-inches, swivel, anneal, transitional fit, cylindricity, parallelism, concentricity, etc.)

1.0202 Read and properly interpret a written set of directions or instructions of machine operations that was written by another student, the instructor, or a machinist.

PERFORMANCE STANDARDS:

- Read technical information concerning machining operations, correctly interpreting the common technical terms used, so that message intended to be communicated is received.
- Instructor's standards apply.

SUGGESTED INSTRUCTION TIME: 3 Hours (Training integrated into all units.)

RELATED TECHNICAL INFORMATION:

- Technical terminology of machine shop trade.

ARTICULATED, PERFORMANCE-BASED DESCRIPTION
OF
BENCHWORK

Benchwork - "Work placed on a bench or in a bench vise for operations usually involving hand tools."

For the purpose of this articulated, performance-based description, benchwork descriptions may be interpreted as including floorwork using the same tools as benchwork, although emphasis in tasks will be on work performed at a bench.

Benchwork Operations - For the purpose of this performance/competency-based description, benchwork operations are represented by:

1. Measuring
2. Work Layout
3. Assembly/Disassembly
4. Chipping
5. Sawing
6. Drilling
7. Reaming
8. Tapping
9. Threading
10. Filing
11. Fitting
12. Scraping
13. Polishing
14. Grinding
15. Inspection
16. Testing

FOR CONVENIENCE, BENCHWORK OPERATIONS ARE ORGANIZED IN THE FOLLOWING UNITS:

1. Using Precision Measuring Instrument
2. Work Layout
3. Benchwork

UNIT 2.0

USING PRECISION MEASURING INSTRUMENTS

Measuring and gaging tools/instruments will be divided into two categories: Semi-precision and precision measuring and gaging tools.

SEMI-PRECISION MEASURING AND GAGING TOOLS

Semi-precision measuring and gaging tools will be used to measure directly or transfer measurements from calipers to a measuring scale to the nearest 1/64 inch.

Emphasis will be on gaining experience in adding and subtracting dimensions to determine wall thickness, depths, accumulation of tolerance limits and tolerances for interchangeability purposes.

Tools may include:

- 6 inch flexible scale
- 12 inch combination set
- tape rule dividers
- inside calipers
- outside calipers
- rule depth gage
- surface gage

PRECISION MEASURING AND GAGING TOOLS

Tools may include:

- micrometers (6 inch outside, inside and depth)
- 6 inch vernier calipers, vernier height gage
- vernier bevel
- protractor
- gage: Telescoping, small hole, radius center, screwpitch
- gage blocks
- sine bar
- sine plate
- planer gage
- adjustable parallel
- dial indicator

Emphasis, for example, will be on measuring directly or transferring measurements from gage to micrometer to within the nearest .001.

NOTE: Tasks in this unit have been arranged in divisions of semi-precision and precision measuring instruments and in a general sequence from simple to complex measuring tasks.

The order of tasks may be learned in a sequence different from that described in this guide. Skill development in some tasks may emphasized the skill related to a specific machining operation some skill development tasks may be reserved for the second year of training.

MACHINE SHOP
USING PRECISION MEASURING INSTRUMENTS
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 2.0	USING PRECISION MEASURING INSTRUMENTS	
2.01	Care for Precision Instruments	1
2.02	Layout Workpiece on Surface Plate	1
2.03	Layout Workpiece with Combination Square	1/2
2.04	Layout Workpiece with Hemaphrodite Calipers	1/2
2.05	Measure Workpiece with 6 Inch Pocket Scale	1/4
2.06	Measure Workpiece with Tape Measure	1/4
2.07	Measure Workpiece on Surface Plate	1 1/4
2.08	Check Workpiece with Sine Bar	1 1/2
2.09	Check Workpiece Using Radius Fillet or Center Gages	1/2
2.10	Measure Inside Diameters with Vernier Caliper	1
2.11	Measure Workpiece with Depth Gages	1/2
2.12	Measure Workpiece with Depth Micrometer	1/2
2.13	Measure Workpiece with Dial Calipers	1/4
2.14	Measure Workpiece with Gage Blocks	3
2.15	Measure Workpiece with Vernier Height Gage	1/2
2.16	Measure Workpiece with Inside Micrometer	1
2.17	Measure Workpiece with Telescope and Hole Gages	1
2.18	Measure Workpiece with Thread Wires	3
2.19	Transfer Dimensions with Divider	1 1/2

2.20	Measure Outside Diameter with Outside Calipers	--
2.21	Measure Round Stock with Outside Micrometer	1
2.22	Measure with Inside Caliper	1/2
2.23	Measure Threads Per Inch with Screw Pitch Gage	1/2
2.24	Measure Screw Threads with Screw Thread Micrometer	1/2
2.25	Describe Optical Comparator	1/2
2.26	Check Round Stock with Dial Indicator	1/2
2.27	Snap Gages (Omitted)	N/A
2.28	Radius Gage	1/2
	TOTAL HOURS	23

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 2.0	USING PRECISION MEASURING INSTRUMENTS
2.01	(Care for Precision Instruments) Given precision machine shop measuring instruments, proper instruction and cleaning materials; clean and return to tool crib/box. Precision instruments must be free of rust and grease and stored properly in the appropriate case/cabinet, according to the instructor's procedures.
2.02	(Layout Workpiece on Surface Plate) Given access to a workpiece, blueprint, surface plate, angle plate, surface gage, vernier height gage, scribe combination square set, scribe dividers, layout dye, files, prick punch, hammer; layout the workpiece. Location of positions must be within +/- .001 inch for decimal dimensions, +/- 1/64 inch for fraction dimensions and +/- 30 minutes on angular dimensions or within blueprint specifications.
2.03	(Layout Workpiece with Combination Square) Furnished with a workpiece, blueprint, and layout instruments including the combination square, scriber, files, layout dye, prick punch, center punch, and layout hammer; layout the workpiece using the combination square. Layout must be to a tolerance of +/- 1/64 inch of blueprint specifications.
2.04	(Layout Workpiece with Hemaphrodite Calipers) Given blueprint, hermaphrodite calipers, combination square and blade, prick punch, hammer, layout dye, and a round workpiece; describe a line parallel to an edge of a workpiece and locate the center of a workpiece to an accuracy of +/- 1/64 inch or meet blueprint specifications.
2.05	(Measure Workpiece with 6 Inch Pocket Scale) Using given pocket scale, blueprint, and workpiece; measure workpiece within a tolerance of +/- 1/64 inch.
2.06	(Measure Workpiece with Tape Measure) Measure given workpiece using given tape rule and blueprint. Workpiece measurements must be within a tolerance of +/- 1/64 inch.
2.07	(Measure Workpiece on Surface Plate) Given a blueprint, workpiece, and measuring instruments to include gage blocks, height gage, dial indicator and stand V-blocks, and surface plate; measure accuracy of the workpiece to a tolerance of +/- 1/64 inch on fraction dimensions and +/- .001 on decimal dimensions or to blueprint specifications.

2.08 (Check Workpiece with Sine Bar) Given a blueprint, Machinery's Handbook, gage blocks, sine bar, surface plate, angle plate, clamps, dial indicator, and workpiece; align workpiece at an angle within +/- 1 minute of blueprint specifications.

2.09 (Check Workpiece Using Radius Fillet or Center Gages) Given workpieces and drawings, and gages; check workpiece for assigned measurements. Workpiece must fit gage so no light shows between gage and workpiece.

2.10 (Measure Inside Diameters with Vernier Caliper) Furnished with a workpiece, blueprint, inside vernier caliper, files, workpiece; measure inside diameters of workpiece to a tolerance of +/- .001 inch.

2.11 (Measure Workpiece with Depth Gages) Supplied with rule depth gage, blueprint, and counterbored workpiece; measure workpiece which must meet blueprint specifications and a tolerance of +/- 1/64 inch with a rule depth and +/- .001 inch with a vernier depth gage.

2.12 (Measure Workpiece with Depth Micrometer) Using furnished depth micrometer, interchangeable measuring rods, machined workpiece, blueprint; measure depth of slot to a tolerance of +/- .001 inch.

2.13 (Measure Workpiece with Dial Calipers) Given a machined workpiece, blueprint and dial caliper; measure the workpiece within a tolerance of +/- .001 inch.

2.14 (Measure Workpiece with Gage Blocks) Given blueprint, workpiece, gage blocks, height gage attachment, surface plate cleaning solution and lint free tissue; measure workpiece within a tolerance of +/- .0001 inch at a temperature as close to 70 degrees as practical.

2.15 (Measure Workpiece with Vernier Height Gage) Using a vernier height gage, offset scriber, surface plate, blueprint, and workpiece; measure work with height gage within a tolerance of +/- .001 inch.

2.16 (Measure Workpiece with Inside Micrometer) Using an inside micrometer, extension rods, spacing collar, handle, steel rule, outside micrometer, standards, blueprint; measure inside diameter of a given workpiece, with +/- .001 inch.

2.17 (Measure Workpiece with Telescope and Hole Gages) Using furnished telescoping gages, small holes gages, micrometer caliper, micrometer standard, and blueprint; measure internal dimensions of workpiece which must be within +/- .001 inch of blueprint specifications.

2.18 (Measure Workpiece with Thread Wires) Using thread measuring wires, micrometer calipers, Machinery's Handbook, blueprint, and furnished workpiece; measure workpiece within tolerance of +/- .001 inch or blueprint specifications.

2.19 (Transfer Dimensions with Divider) Given a divider, machinist scale, drawing, and workpiece and other materials needed; transfer dimensions of the drawing to the workpiece using dividers and machinist's scale with an accuracy of +/- 1/64 inch.

2.20 (Measure Outside Diameter with Outside Calipers) Given the outside caliper, machinist's rule, drawing, and round workpiece; measure the outside diameter of the round workpiece within +/- 1/64 inch.

2.21 (Measure Round Stock with Outside Micrometer) Given an outside micrometer, instruction concerning its operations, and round stock and flat stock; measure the outside diameter of round stock and the thickness of flat stock and the length of flat stock using the outside micrometer.

2.22 (Measure with Inside Caliper) Given an inside caliper, outside micrometer, workpiece of tubular stock, and required materials; measure the inside diameter of the tubular stock within +/- .002 inches of specifications.

2.23 (Measure Threads Per Inch with Screw Pitch Gage) Given a screw pitch gage and screws or bolts with standard threads, measure the number of threads per inch of given screws or bolts with screw pitch gage.

2.24 (Measure Screw Threads with Screw Thread Micrometer) Given a screw thread micrometer and screws to measure, measure the pitch diameter of screw threads within +/- .001 inches of specifications using the screw thread micrometer.

2.25 (Describe Optical Comparator) Given an orientation to the optical comparator, describe the optical comparator and explain how it is used for checking work.

2.26 (Check Round Stock with Dial Indicator) Given a dial indicator and round stock, check the concentricity of the round stock to within +/- .001 inches.

2.27 (Snap Gages [Omitted]) Because snap gages such as GO/NO GO gages are used more in production work and are not readily available in the training programs, they currently are omitted from secondary training.

2.28 (Radius Gage) Using a radius gage provided, measure convex and concave radii of given parts to the instructor's standards.

UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS
TASK	2.01	CARE FOR PRECISION INSTRUMENTS

PERFORMANCE OBJECTIVE:

Given precision machine shop measuring instruments, proper instruction and cleaning materials; clean and return to tool crib/box. Precision instruments must be free of rust and grease and stored properly in the appropriate case/cabinet, according to the instructor's procedures.

PERFORMANCE ACTIONS:

2.0101 Check instruments for proper operation/damage.

2.0102 Remove grease from instruments by applying an appropriate cleaning solution and wiping surfaces clean and dry.

2.0103 Insure instrument is aligned and adjust instrument for proper setting for storage, given adjustment instruction.

2.0104 Store instrument in proper case/cabinet/locations.

PERFORMANCE STANDARDS:

- Care for precision instruments of the machine shop by cleaning and storing the instruments in the proper locations and according to instructor procedures.
- Instruments must be free of rust and stored properly.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Identify semi-precision and precision measuring instruments with an accuracy of 95 percent.
- Cleaning rust from tools if needed.
- Lubrication of specific instrument.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.02 LAYOUT WORKPIECE ON SURFACE PLATE

PERFORMANCE OBJECTIVE:

Given access to a workpiece, blueprint, surface plate, angle plate, surface gage, vernier height gage, scribe, combination square set, scribe dividers, layout dye, files, prick punch, hammer; layout the workpiece. Location of positions must be within +/- .001 inch for decimal dimensions on angular dimensions or within blueprint specifications.

PERFORMANCE ACTIONS:

2.0201 Remove all burrs on workpiece.

2.0202 Clean workpiece and coat surface with dye.

2.0203 Align workpiece:

a. Place angle plate carefully on surface plate.
b. Align workpiece so that all dimensions can be made from surface plate or reference point.
c. Mount workpiece and clamp to angle plate (use a straightedge of the workpiece as a base).

2.0204 Scribe a reference or base line on workpiece:

a. Use a straightedge on workpiece as base if possible.
b. Set vernier height gage to blueprint dimensions.

2.0205 Scribe lines in accordance with blueprint specifications:

a. Set vernier height gage to required dimensions.
b. Scribe all horizontal lines using protractor.
c. Scribe angular lines using protractor.
d. Scribe arcs and circles with scribe dividers.

2.0206 Assure scribed lines are within specified tolerances.

PERFORMANCE STANDARDS:

- Layout work on surface plate with positions within +/- .001 inch, +/- 1/64 inch, +/- 30 minutes, or within blueprint specifications.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 2.0 USING SEMI-PRECISION MEASURING INSTRUMENTS

TASK 2.03 LAYOUT WORKPIECE WITH COMBINATION SQUARE

PERFORMANCE OBJECTIVE:

Furnished with a workpiece, blueprint, and layout instruments including the combination square, scriber, files, layout dye, prick punch, center punch, and layout hammer; layout the workpiece using the combination square. Layout must be to a tolerance of +/- 1/64 inch or blueprint specifications.

PERFORMANCE ACTIONS:

2.0301 Deburr and clean workpiece.

2.0302 Coat surface with layout dye.

2.0303 Select reference surface or edge on workpiece:

- a. Check blueprint for reference edge.
- b. Use finished surface for reference on workpiece.

2.0304 Scribe one end of workpiece:

- a. Allow room for complete layout on workpiece.
- b. Scribe perpendicular to reference edge.

2.0305 Scribe centerlines of arcs and holes.

2.0306 Prick punch hole locations on centerlines.

2.0307 Scribe arcs and holes, as necessary.

2.0308 Check against blueprint specifications:

- a. Approved workpiece.
- b. Correct layout by recoating workpiece with layout dye and completely layout again until all designated dimensions are within tolerance specified.

PERFORMANCE STANDARDS:

- Layout workpiece with combination square to a tolerance of +/- 1/64 inch or blueprint specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

EXPANSION OF TASK:

- Locate and mark center of both ends of a round bar of any size from 1/4 inch to 6 inches using the center head of the combination set. Must be within +/- 1/32 inch of specifications.

UNIT 2.0 USING SEMI-PRECISION MEASURING INSTRUMENTS

TASK 2.04 (Optional) LAYOUT WORKPIECE WITH HEMAPHRODITE CALIPERS

PERFORMANCE OBJECTIVE:

Given blueprint, hermaphrodite calipers, combination square and blade, prick punch, hammer, layout dye, and a round workpiece; scribe a line parallel to an edge of a workpiece and locate the center of a workpiece to an accuracy of +/- 1/64 inch or meet blueprint specifications.

PERFORMANCE ACTIONS:

2.0401A Scribe line parallel to an edge (flat workpiece)

1. Clean and deburr workpiece.
2. Set hermaphrodite calipers on designated setting.
   a. Place hooked leg against end of square blade.
   b. Adjust scriber leg to setting.
   c. Use fine adjustment for final setting.
3. Scribe line parallel to edge of workpiece.
   a. Coat workpiece with layout dye.
   b. Refer to blueprint for reference edge.
   c. Hold hooked leg against edge and move calipers parallel to edge.
   d. Hold calipers perpendicular to edge when scribing line.
4. Check layout to see if layout lines meet tolerance specifications.
5. If line not within tolerance, repeat steps 2-4 until workpiece meets designated specifications.

2.0401B Locate center of round workpiece

1. Clean and deburr workpiece.
2. Coat end of workpiece with layout dye.
3. Set divider leg at required radius.
   a. Measure workpiece and set dividers at one-half diameter or workpiece - plus.
   b. Place hooked leg on end of rule and adjust scribed leg to required radius.
4. Scribe arcs on end of workpiece.
   a. Use four arcs at 90 degrees apart on workpiece.
   b. Hold calipers perpendicular to end of workpiece.

UNIT 2.0 USING SEMI-PRECISION MEASURING INSTRUMENTS

TASK 2.04 (Optional) LAYOUT WORKPIECE WITH HEMAPHRODITE CALIPERS

PERFORMANCE ACTIONS (Con't.):

5. Mark center of workpiece in center of arcs with prick punch.
6. Check center location with rule.
   a. Approve workpiece.
   b. Redo steps 2-6 until workpiece meets designated specifications.

PERFORMANCE STANDARDS:

- Layout work with hemaphrodite calipers by scribing a line parallel to an edge of a workpiece and locate the center of a round workpiece to an accuracy of +/- 1/64 inch or meet blueprint specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Scribe angles and parallel lines with the hermaphrodite calipers.
- Optional but similar to GTC's MS-3-5 Package.

UNIT	2.0	USING SEMI-PRECISION MEASURING INSTRUMENTS
TASK	2.05	MEASURE WORKPIECE WITH 6 INCH POCKET SCALE

PERFORMANCE OBJECTIVE:

Using given pocket scale, blueprint, and workpiece; measure workpiece within a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

2.0501 Check blueprint for required dimension.

2.0502 Measure workpiece:

a. Select reference point.
b. Use 1/64 inch graduated scale.
c. Stand rule on edge to avoid parallel error.
d. Avoid using end of rule because of possible wear on rule.
e. Use one inch mark as reference.
f. Allow for this one inch in calculating measurement.
g. If measuring an end diameter, move rule until largest reading is obtained.
h. Repeat measuring until two or more measurements are within tolerance.

PERFORMANCE STANDARDS:

- Measure workpiece within a tolerance of +/- 1/64 inch using the 6 inch pocket scale.

SUGGESTED INSTRUCTION TIME: 1/4 Hour

RELATED TECHNICAL INFORMATION:

- Measuring using 1/64 inch scale.
- Use 12 inch pocket scale.

UNIT 2.0 USING SEMI-PRECISION MEASURING INSTRUMENTS

TASK 2.06 MEASURE WORKPIECE WITH TAPE MEASURE

PERFORMANCE OBJECTIVE:

Measure given workpiece using given tape rule and blueprint. Workpiece measurements must be within a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

2.0601 Measure workpiece:

a. Inside measurements add 2 inches for rule case, if applicable.
b. Butt hook against workpiece on inside measurement.
c. Hook rule over edge or workpiece on outside measurements.

2.0602 Verify workpiece dimension as within/without specified tolerance.

PERFORMANCE STANDARDS:

- Measure workpiece with tape measure within a tolerance of +/- 1/64 inch.

SUGGESTED INSTRUCTION TIME: 1/4 Hour

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.07 MEASURE WORKPIECE ON SURFACE PLATE

PERFORMANCE OBJECTIVE:

Given a blueprint, workpiece, and measuring instruments to include gage blocks, height gage, dial indicator and stand, V-blocks, and surface plate; measure accuracy of the workpiece to a tolerance of +/- 1/64 inch on fraction dimensions and +/- .001 on decimal dimensions or to blueprint specifications.

PERFORMANCE ACTIONS:

2.0701 Remove cover from surface plate. Return cover when surface plate not in use.

2.0702 Wipe surface plate clean with rag.

- a. Burrs, sharp edges and rough areas on work must be removed prior to placing the workpiece on the surface plate.
- b. Place work on surface plate carefully to avoid scratches and nicks to plate.
- c. Set workpiece on V-blocks if applicable.

2.0703 Set up for measurement:

- a. Build gage blocks to blueprint specifications according to instruction.
- b. Attach dial indicator to stand.
- c. Place assembled dial indicator to plate.

2.0704 Take measurement of workpiece:

- a. Align dial indicator to gage blocks.
- b. Set dial indicator to "zero" reading.
- c. Place dial indicator against surface to be checked on workpiece.
- d. Record dial indicator measurement.
- e. Accept workpiece as within dimension tolerance or reject workpiece.

PERFORMANCE STANDARDS:

- Measure workpiece on surface plate to a tolerance of +/- 1/64 inch on fractional dimensions and to +/- .001 on decimal dimensions or to blueprint specifications.
- Procedures must meet instructor's standards.

TASK 2.07 MEASURE WORKPIECE ON SURFACE PLATE (Con't.)

SUGGESTED INSTRUCTION TIME: 1 1/4 Hours

RELATED TECHNICAL INFORMATION:

- Read fractional dimensions to +/- 1/64 inch.
- Read decimal dimensions to +/- .001.
- Care and use of granite surface plate.
- Use and care of measuring instruments.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.08 CHECK WORKPIECE WITH SINE BAR

PERFORMANCE OBJECTIVE:

Given a blueprint, Machinery's Handbook, gage blocks, sine bar, surface plate, angle plate, clamps, dial indicator, and workpiece; align workpiece at an angle within +/- 1 minute of blueprint specifications.

PERFORMANCE ACTIONS:

2.0801 Place angle plate on surface plate:

- a. Check angle plate for burrs or chips.
- b. Clean surface plate.

2.0802 Determine angle requirement:

- a. Check blueprint for angle.
- b. Select sine bar.
- c. Check Machinery's Handbook for gage block assembly.
- d. Clean and wring gage blocks.
- e. Place sine bar on gage blocks against angle plate.

2.0803 Mount dial indicator on stand.

2.0804 Set dial indicator against sine bar and set to "zero."

2.0805 Clamp workpiece to angle plate.

2.0806 Align workpiece with dial indicator within blueprint specifications.

PERFORMANCE STANDARDS:

- Check work with sine bar so workpiece aligns at an angle +/- 1 minute of blueprint specifications.*

SUGGESTED INSTRUCTION TIME: 1 1/2 Hours

*NOTE: GTC's MS-3-24 standards are +/- 0°5'.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.09 CHECK WORKPIECE USING RADIUS FILLET OR CENTER GAGES

PERFORMANCE OBJECTIVE:

Given workpiece and drawings, and gages; check workpiece for assigned measurements. Workpiece must fit gage so no light shows between gage and workpiece.

PERFORMANCE ACTIONS:

2.0901 Select gage.

2.0902 Place properly on workpiece.

2.0903 Check for light showing between gage and workpiece.

2.0904 a. File or hone high spots.
b. Machine workpiece again if high spots cannot be removed by filling or honing.
c. Regrind workpiece if necessary.

2.0905 Continue above steps until workpiece fits gage.

PERFORMANCE STANDARDS:

- Check workpiece with proper gages, honing or filing as necessary so that the workpiece fits the gage so no light shows between the gage and workpiece.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Use of center, fillet, and radius gages for accurate bench work operations.
- Machinery's Handbook.

UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS
TASK	2.10	MEASURE INSIDE DIAMETERS WITH VERNIER CALIPER

PERFORMANCE OBJECTIVE:

Furnished with a workpiece, blueprint, inside vernier caliper, files; measure inside diameters of workpiece to a tolerance of +/- .001 inch.

PERFORMANCE ACTIONS:

2.1001 Select appropriate caliper for the workpiece.

2.1002 Check caliper for zero setting and adjust as necessary.

2.1003 Adjust sliding jaw to inside diameter and lock.

2.1004 Take inside diameter measurements by adjusting vernier scale with fine adjustment:

a. Avoid excessive pressure to prevent springing the jaw.
b. Keep calipers on centerline for measurements.
c. Read caliper while in place on the workpiece.
d. Take at least two separate readings for verification.

2.1005 Repeat steps for measuring outside diameter until measurements are within tolerance.

PERFORMANCE STANDARDS:

- Measure inside diameters of workpiece with vernier caliper to a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Reading vernier scale.
- Interpreting tolerances.
- Measuring stock with vernier caliper.

TASK 2.11 MEASURE WORKPIECE WITH DEPTH GAGES

PERFORMANCE OBJECTIVE:

Supplied with rule depth gage, vernier depth gage, blueprint, and counterbored workpiece; measure workpiece which must meet blueprint specifications and a tolerance of +/- 1/64 inch with a rule depth and +/- .001 inch with a vernier depth gage.

PERFORMANCE ACTIONS:

2.1101A Rule Depth Gage:

1. Slide rule as far as it will go into hole without disturbing contact of gage head and work.
2. Tighten clamp nut.
3. Remove from hole and read depth dimension on rule at junction with gage head.
4. Verify workpiece dimensions to specified tolerance.

2.1101B Vernier Depth Gage:

1. Hold base firmly on reference surface.
2. Lock rule in place with lock screw.
3. Adjust vernier movement to light contact with bottom of hole.
4. Remove gage and read vernier setting.
5. Verify workpiece dimensions as to specified tolerance.

PERFORMANCE STANDARDS:

- Measure given workpiece with depth rule depth gage to a tolerance of +/- 1/64 inch and with vernier depth gage to +/- .001 inch or meet blueprint specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS
TASK	2.12	MEASURE WORKPIECE WITH DEPTH MICROMETER

PERFORMANCE OBJECTIVE:

Using furnished depth micrometer, interchangeable measuring rods, machined workpiece, blueprint; measure depth of slot to a tolerance of +/- .001 inch.

PERFORMANCE ACTIONS:

2.1201 Identify interchangeable measuring rod.

2.1202 Insert correct measuring rod into micrometer.

2.1203 Set micrometer on reference surface and turn thimble until rod touches bottom of slot:

  a. Hold micrometer base firmly on reference surface.
  b. Use light touch with rod.

2.1204 Remove micrometer and note reading:

  a. Take more than one measurement for verification.

PERFORMANCE STANDARDS:

- Measure machined workpiece with depth micrometer to a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

UNIT 2.0 USING PRECISION MEASURING

TASK 2.13 MEASURE WORKPIECE WITH DIAL CALIPERS

PERFORMANCE OBJECTIVE:

Given a machined workpiece, blueprint and dial caliper; measure the workpiece within a tolerance of +/- .001 inch.

PERFORMANCE ACTIONS:

2.1301 Check drawing for dimensions.

2.1302 With calipers closed, set dial indicator on "0".

2.1303 Open calipers until outside or inside jaws touch the surfaces to be measured:

- a. Measure across centerline or workpiece.
- b. Use light touch.
- c. Keep calipers on workpiece while taking caliper reading.

2.1304 Obtain dimensions by reading the main scale and adding the reading on the dial indicator.

2.1305 Note workpiece dimensions to specified tolerance.

PERFORMANCE STANDARDS:

- Measure work with dial calipers within a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 1/4 Hour

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.14 MEASURE WORKPIECE WITH GAGE BLOCKS

PERFORMANCE OBJECTIVE:

Given blueprint, workpiece, gage blocks, height gage attachment, surface plate cleaning solution, and lint free tissue; measure workpiece within a tolerance of +/- .0001 inch at a temperature as close to 70 degrees as practical.

PERFORMANCE ACTIONS:

2.1401 Check drawing for required dimensions.

2.1402 Clean workpiece and place on surface plate.

2.1403 Select required gage blocks and attachments:

  a. Calculate gage blocks required.
  b. Use wear blocks.

2.1404 Clean gage blocks.

2.1405 Wring gage blocks.*

2.1406 Add a holder to gage blocks, if available.

2.1407 Measure workpiece with gage block assembly.

2.1408 Verify workpiece dimensions to specified tolerance.

PERFORMANCE STANDARDS:

- Measure given workpiece with gage blocks within a tolerance of +/- .0001 inch. (Verify accuracy of dial indicator to +/- .001 inch.)

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- *Gage blocks may be "wrung together" to form a stack of blocks.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.15 MEASURE WORKPIECE WITH VERNIER HEIGHT GAGE

PERFORMANCE OBJECTIVE:

Using a vernier height gage, offset scriber, surface plate, blueprint, and workpiece; measure work with height gage within a tolerance of +/- .001 inch.

PERFORMANCE ACTIONS:

2.1501 Clean surface plate.

2.1502 Set workpiece and height gage on surface plate.

2.1503 Assemble offset scriber in height gage.

2.1504 Check zero setting of height gage on reference point.

2.1505 Slide vernier scale so scriber is just above height to be measured on workpiece.

2.1506 Lock vernier scale.

2.1507 Turn fine adjustment until scriber touches workpiece.

2.1508 Lock fine adjustment knob.

2.1509 Take reading on vernier scale.

PERFORMANCE STANDARDS:

- Measure workpiece with height gage within a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.16 MEASURE WORKPIECE WITH INSIDE MICROMETER

PERFORMANCE OBJECTIVE:

Using an inside micrometer, extension rods, spacing collar, handle, steel rule, outside micrometer, standards, blueprint; measure inside diameter of a given tubular stock workpiece, within +/- .001 inch.

PERFORMANCE ACTIONS:

2.1601 Measure inside diameter of workpiece with steel rule.

2.1602 Assemble extension rod in micrometer:

- a. Check shoulder setting.
- b. Check length of micrometer with steel rule.
- c. Use spacing collar if applicable.

2.1603 Measure inside diameter of workpiece:

- a. Use handle with micrometer.
- b. Hold one end of micrometer firmly against side of hole.
- c. Move other end of the micrometer in arc movement until largest setting obtained.

2.1604 Read micrometer reading:

- a. Add extension rod length to micrometer reading.
- b. Add spacing collar length if one is used.
- c. Check reading against micrometer.
- d. Take more than one measurement.

2.1605 Assure workpiece is to specified tolerance of +/- .001 inch.

PERFORMANCE STANDARDS:

- Measure inside of tubular stock workpiece with inside micrometer with +/- .001 inch tolerance.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.17 MEASURE WORKPIECE WITH TELESCOPE AND HOLE GAGES

PERFORMANCE OBJECTIVE:

Using furnished telescoping gages, small holes gages, micrometer caliper, micrometer standard, and blueprint; measure internal dimensions of workpiece within +/- .001 inch of blueprint specifications.

PERFORMANCE ACTIONS:

2.1701 Select gage for desired measurement.

2.1702 Insert gage in hole or slot and release lock screw.

2.1703 Adjust gage to fit workpiece:

Small Hole Gage:
a. Select gage.
b. Move gage until it touches workpiece.
c. Move gage back and forth to obtain a feel of measurement.
d. Withdraw from workpiece.
e. Check measurement.

Telescoping Gage:
a. Select gage.
b. Insert into workpiece.
c. Rock gage to obtain largest measurement and lock gage lightly.
d. Use downward pressure and roll gage.
e. Lock gage firmly and check measurement.

2.1704 Measure gage setting with micrometer:

a. Check micrometer with gage or zero setting.
b. Avoid excessive pressure with micrometer caliper.

2.1705 Repeat steps c-e (Telescoping Gage) to verify reliability of measurement.

PERFORMANCE STANDARDS:

- Measure internal dimensions of workpiece with telescope and hole gages within +/- .001 inch of specifications.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.18 MEASURE WORKPIECE WITH THREAD WIRES

PERFORMANCE OBJECTIVE:

Using thread measuring wires, micrometer calipers, Machinery's Handbook, blueprint, and furnished workpiece; measure workpiece within tolerance of +/- .001 inch or blueprint specifications.

PERFORMANCE ACTIONS:

2.1801 Select micrometer caliper:

a. Check micrometer with gage standards.

2.1802 Select thread measuring wires:

a. Check Machinery's Handbook for formula.
b. Check appropriate (best) wire size.
c. Check measuring wires with micrometer caliper.

2.1803 Measure workpiece with thread measuring wires:

a. Place two wires on one side and one on opposite side.

2.1804 Verify workpiece dimensions to specified tolerances.

PERFORMANCE STANDARDS:

- Measure workpiece with thread wires within a tolerance of +/- .001 inch or blueprint specifications.

SUGGESTED INSTRUCTION TIME: 3 Hours

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.19 (Optional) TRANSFER DIMENSIONS WITH DIVIDER

PERFORMANCE OBJECTIVE:

Given a divider, machinist scale, drawing, and workpiece and other materials needed; transfer dimensions of the drawing to the workpiece using dividers and machinist's scale with an accuracy of +/- 1/64 inch.

PERFORMANCE ACTIONS:

2.1901	Assemble divider, machinist's scale, workpiece, etc.
2.1902	Take measurement with divider or set divider to measurements indicated.
2.1903	Transfer measurements from divider to workpiece or to machinist's scale and then to workpiece.
2.1904	Measure distances, layoff distances, and scribe circles using the divider.

PERFORMANCE STANDARDS:

- Transfer dimensions from drawing provided to workpiece using divider, machinist's scale, and other materials provided.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Use of machinist's scale.
- Measuring to +/- 1/64 inch accuracy.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.20 (Optional) MEASURE OUTSIDE DIAMETER WITH OUTSIDE CALIPERS

PERFORMANCE OBJECTIVE:

Given the outside caliper, machinist's rule, drawing, and round workpiece; measure the outside diameter of the round workpiece within +/- 1/64 inch.

PERFORMANCE ACTIONS: (Measure workpiece with caliper.)

2.2001 Assemble tools.

2.2002 Hold caliper in hand, firmly but gently allowing caliper legs to contact work.

2.2003 Adjust knurled adjustment nut with thumb and forefinger until weight of caliper leg causes it to slip over work.

2.2004 Remove caliper carefully from work so setting is not disturbed.

2.2005 Measure distance between caliper legs with steel rule and read dimensions.

(NOTE: Gage machine part to required size by setting caliper to given dimension from steel rule and transferring/checking dimensions.)

PERFORMANCE STANDARDS:

- Measure outside diameter of round workpiece with outside calipers and machinist's rule with an accuracy of +/- 1/64 inch.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Use of machinist's rule.
- Measuring with an accuracy of +/- 1/64 inch.
- Transferring measurements.

RELATED TECHNICAL INFORMATION (Con't.):

- Reading the scale: By looking squarely at rule, with light falling directly on rule, caliper tips splitting graduation line.
- NOTE: Calipers typically used for rough machine operations, not for highly accurate measurements.

EXPANDED TRAINING:

- Use of the micrometer for quicker, more dependable, and more precision measuring.

UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS
TASK	2.21	MEASURE ROUND STOCK WITH OUTSIDE MICROMETER

PERFORMANCE OBJECTIVE:

Given an outside micrometer, and instruction concerning its operation, and round stock and flat stock; measure the outside diameter of round stock and the thickness of flat stock and the length of flat stock using the outside micrometer.

PERFORMANCE ACTIONS:

2.2101 Obtain outside micrometer from toolroom, etc.

2.2102 Make sure micrometer is adjusted accurately to "zero" of set to known precision standard gage.

2.2103 Clean anvil and spindle face.

2.2104 Hold micrometer by frame, not thimble.

2.2105 Place anvil against work, seating anvil and spindle squarely on the true diameter of the workpiece.

2.2106 Adjust proper pressure with thimble or ratchet device.*

2.2107 Lock measurement by spindle locknut, remove mike, and read measurement.**

(NOTE: Instructor will provide instruction concerning transferring measurements with the micrometer.)

* Never tighten spindle so tight that work cannot be removed from between anvil and spindle.

** A more accurate measurement may be obtained by reading the micrometer prior to removing it from the work.

PERFORMANCE STANDARDS:

- Measure round stock with the outside micrometer.
- Measure the thickness of flat stock.
- Measure the length of flat stock.
- Measurements should be accurate within .001 inch.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.21 MEASURE ROUND STOCK WITH OUTSIDE MICROMETER (Con't.)

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Adjust spindle pressure to correct tension or until ratchet clicks twice.
- Do not slide micrometer back and forth excessively across the workpiece since this may wear away the face of both the anvil and spindle.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.22 MEASURE WITH INSIDE CALIPER

PERFORMANCE OBJECTIVE:

Given an inside caliper, outside micrometer, workpiece of tubular stock, and required materials; measure the inside diameter of the tubular stock within +/- .002 inch of specifications.

PERFORMANCE ACTIONS: (See steps for using outside caliper.)

2.2201 Correctly hold caliper in hand.

2.2202 Allow caliper legs to contact workpiece.

2.2203 Adjust knurled adjustment nut for measurement.

2.2204 Remove caliper.

2.2205 Transfer measurement to outside micrometer.

2.2206 Read measurement taken.

PERFORMANCE STANDARDS:

- Measure with inside caliper and outside micrometer a tubular stock workpiece within +/- .002 inch of specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Use of outside micrometer.
- Proper technique of measuring inside diameter of tubular stock.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.23 MEASURE THREADS PER INCH WITH SCREW PITCH GAGE

PERFORMANCE OBJECTIVE:

Given a screw pitch gage and screws or bolts with standard threads, measure the number of threads per inch of given screws or bolts with screw pitch gage.

PERFORMANCE ACTIONS:

2.2301 Obtain screw pitch gage from toolroom.

2.2302 Assemble screws or bolts to measure.

2.2303 Match the teeth of one of the leaves (screw pitch gage) with the thread on the screw or bolt being measured.

2.2304 Read the pitch of the thread from the lead.

(NOTE: Gages are available for English and Metric threads.)

PERFORMANCE STANDARDS:

- Measure threads per inch of given screws and bolts with the screw pitch gage.
- At minimum, training should be orientation.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS
TASK	2.24 (Optional)	MEASURE SCREW THREADS WITH SCREW THREAD MICROMETER

PERFORMANCE OBJECTIVE:

Given a screw thread micrometer and screws to measure, measure the pitch diameter of screw threads within +/- .001 inch of specifications using the screw thread micrometer.

PERFORMANCE ACTIONS:

2.2401 Obtain screw thread micrometer.

2.2402 Correctly holding instrument in hand.

2.2403 Place anvil and spindle over thread to be measured.

2.2404 Contact thread with anvil and spindle.

2.2405 Read pitch diameter on sleeve and spindle.

2.2406 Compare with correct pitch diameter by screw from table of threads provided by instructor.

PERFORMANCE STANDARDS:

- Measure given screw threads with screw thread micrometer with accuracy of +/- .001 inch of specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hour (Optional-Orientation)

RELATED TECHNICAL INFORMATION:

- Markings of thread micrometers: (e.g., 8-13, 14-20, 22-30, 32-40)
- Selecting the proper micrometer.
- Point out uses: Lathe operator and inspection department.
- Procedures for measuring screw threads.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.25 DESCRIBE OPTICAL COMPARATOR

PERFORMANCE OBJECTIVE:

Given an orientation to the optical comparator, describe the optical comparator and explain how it is used for checking work.

PERFORMANCE ACTIONS:

2.2501 Observe information provided by the instructor concerning the optical comparator, including construction, typical operation, and use in the machine shop.

2.2502 Identify how to use a template or comparator chart with the optical comparator in checking workpiece.

2.2503 Identify accuracy of comparisons that can be made on optical comparator:

a. +/- .001 inch decimal dimensions.
b. +/- 1 degree angular.

2.2504 Perform other activities to become familiar with the optical comparator as might be required by the instructor.

PERFORMANCE STANDARDS:

- Identify the optical comparator.
- Describe in basic terms how the optical comparator works.
- Explain how the comparator is set up for use by the machinist.
- Explain how measurements are made using the optical comparator and what accuracy may be obtained.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Measuring to .001 inch and 1 degree of accuracy.
- Use of template or comparator chart.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.26 CHECK ROUND STOCK WITH DIAL INDICATOR*

PERFORMANCE OBJECTIVE:

Given a dial indicator and round stock, check the concentricity of the round stock to within +/- .001 inch.

PERFORMANCE ACTIONS:

2.2601 Obtain dial indicator from toolroom.

2.2602 Set up to measure the concentricity of given round stock.

2.2603 Measure concentricity of round stock to within +/- .001 inch using the dial indicator.

PERFORMANCE STANDARDS:

- Check concentricity of given round stock to within +/- .001 inch using the dial indicator.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Describe/identify a dial indicator.
- Explain how to set the shop dial indicator(s) to "zero."
- Explain uses of the dial indicator: To set up machine, inspect tools and machines, etc. Readings used to check size, center work, etc., where balanced readings are needed.
- Identify that the dial indicator must be mounted at right angles to workpiece to assure full movement is registered on dial.

*Normally a mike will be used.

UNIT 2.0 USING PRECISION MEASURING INSTRUMENTS

TASK 2.27 (Optional) SNAP GAGES (OMITTED)

PERFORMANCE OBJECTIVE:

Because snap gages such as GO/NO GO gages are used more in production work and are not readily available in the training programs, they currently are omitted from secondary training.

PROBABLE PERFORMANCE OBJECTIVE:

Given snap gages, measure lengths, diameters, and thickness of given parts. Performance must be to the instructor's standards.

PERFORMANCE ACTIONS: (As application, to be defined by instructor.)

PERFORMANCE STANDARDS: (Optional)

- Measure lengths, diameters, and thickness of given parts with snap gages to the instructor's standards.

SUGGESTED INSTRUCTION TIME: N/A

TASK 2.28 RADIUS GAGE

PERFORMANCE OBJECTIVE:

Using a radius gage provided, measure convex and concave radii of given parts to the instructor's standards.

PERFORMANCE ACTIONS: (If applicable, to be defined by instructor.)

PERFORMANCE STANDARDS:

- Measure convex and concave radii of given parts using a radius gage provided.
- Instructor's standards apply.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Check layout radius or fillets ranging from 1/64 inch to 1/2 inch.

UNIT 3.0

WORK LAYOUT

While described as a separate unit, these training objectives on work layout may be integrated with training concerning hand tools, measuring tools, benchwork, or other topics that the instructor may decide is appropriate.

Some tasks in this unit such as laying out angles, bolt circle coordinates, bolt circle chords, etc., may be introduced during the first year and studied in depth for skill competency during the second (advanced layout).

STANDARDS
APPLICABLE TO MOST WORK LAYOUTS

These performance actions and standards will apply to most layout tasks and will not be repeated.

1. Review and take proper care of blueprints, drawings, and specifications:
    a. Keep blueprints, working drawings, and specifications clean, not damaged, and in order.
    b. When job is completed (prints no longer needed), return prints, etc., to proper file/storage as required.

2. Follow an accepted layout procedure:
    a. Establish horizontal and vertical base or reference lines.
    b. Make each layout line or point from base (reference) lines.
    c. Use only clean, sharp scribed lines. Remove and layout new line if line is double or poorly marked.

3. Follow logical steps in making layout of work plan:[1]
    a. Study blueprints (step 1 above).
    b. Select material described in specifications.
    c. Cut material to proper size, length, and quantity.
    d. Remove sharp edges and burrs.
    e. Clean workpiece of grease/oil.
    f. Apply layout fluid to provide a contrasting background for scribed lines.
    g. Select proper layout tools.
    h. Measure and mark accurate reference edges from which to work.
    i. Mark lower left-hand corner "X" and work from edges A and B. If edge A is not true, scribe vertical line 90 degrees to edge B.
    j. From these edges (A & B), layout all horizontal and vertical centerlines to locate hole locations. Always layout all lines from baseline reference.
    k. Check center-to-center layout centerlines against working print and make necessary corrections.
    l. Scribe arcs and circles and layout angular lines and point-to-point connecting lines.
    m. Use prick punch to mark exact points where horizontal and vertical lines intersect.
    n. Scribe reference lines showing locations of holes, etc.
    o. Prick punch circumference of scribed reference circles (planned holes).
    p. Center punch all center points.

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[1] Standards adopted from Dixon, Robert G., Benchwork, Delmar, NY; Delmar Publishers Inc., pp. 97-103, 1981.

(Instructor may substitute another procedure.)

MACHINE SHOP
WORK LAYOUT
SUGGESTED INSTRUCTION TIME

WORK LAYOUT UNIT/TASK		SUGGESTED HOURS
Unit 3.0	WORK LAYOUT	
3.01	Scribe Workpieces	3
3.02	Mark Locations with Prick Punch and Center Punch	3
3.03	Locate Holes with Transfer Punches	3
3.04	Layout Hole Spacing and Outside Dimensions	3
3.05	Layout Angles	3
3.06	Layout a Bolt Circle	3
3.07	Layout Compound Angles	3
3.08	Layout Tangents	3
	TOTAL HOURS	24

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 3.0	WORK LAYOUT
3.01	(Scribe Workpieces) Given work bench, cylindrical and rectangular stock, dimensioned blueprints or drawings, and the necessary layout and scribing tools, measuring instruments, and materials; scribe the workpieces. The stock must be scribed to specifications within a tolerance of +/- 0.001 inch using a height gage, radius gage.
3.02	(Make Locations with Prick Punch and Center Punch) Given blueprint or specifications, layed out workpiece, center punch hole location to an accuracy of +/- 1/64 inch or to specifications.
3.03	(Locate Holes with Transfer Punches) Given workpiece blueprint/specifications, locate holes in workpiece with transfer instruments. Located holes must meet blueprint specifications.
3.04	(Layout Hole Spacing and Outside Dimensions) Given rectangular stock, a dimensioned blueprint/drawing and specifications, combination square, and the necessary layout and scribing tools, measuring instruments, and materials; layout hole spacing and outside dimensions to a tolerance of +/- 1/64 inch.
3.05	(Layout Angles) Given rectangular stock, dimensioned blueprint/drawing, specifications, bevel protractor, necessary layout and scribing tools, measuring instruments, and materials; layout angles on the stock to a tolerance of +/- 1 minute.
3.06	(Layout a Bolt Circle) Given pre-cut stock, detailed drawing and specifications, combination square, measuring instruments, and necessary layout and scribing tools, layout a bolt circle on the stock to specifications within +/- 1/64 inch.
3.07	(Layout Compound Angles) Given pre-cut stock, detailed drawing and specifications, combination square, bevel protractor, measuring instruments, and necessary layout and scribing tools, layout compound angles on stock to specifications with a tolerance of +/- 1 minute.
3.08	(Layout Tangents) Given pre-cut stock, detailed drawing and specifications, measuring instruments, combination square, bevel protractor, and necessary layout and scribing tools; layout angles tangent to radii on the stock to specifications within +/- 1 degree.

UNIT 3.0 WORK LAYOUT

TASK 3.01 SCRIBE WORKPIECES

PERFORMANCE OBJECTIVE:

Given work bench, cylindrical and rectangular stock, dimensioned blueprints or drawings, and the necessary layout and scribing tools, measuring instruments, and materials; scribe the workpieces. The stock must be scribed to specifications within a tolerance of +/- 0.001 inch using a height gage, radius gage.

PERFORMANCE ACTIONS:

3.0101 Select scriber.

3.0102 Demonstrate how to scribe circles, radii, and parallel lines on workpiece.

PERFORMANCE STANDARDS:

- Scribe workpieces provided to specifications with a tolerance of +/- 0.001 inch using height gage and +/- 1/64 inch using radius gage.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Identify and explain use of surface plate, height gage, and dividers.
- Describe procedures for scribing workpiece.
- Explain how to maintain and store height gage and surface plate.
- Safety precautions.
- Proper techniques in use of scriber.

UNIT 3.0 WORK LAYOUT

TASK 3.02 MARK LOCATIONS WITH PRICK PUNCH AND CENTER PUNCH

PERFORMANCE OBJECTIVE:

Given blueprint or specifications, layed out workpiece, center punch hole location to an accuracy of +/- 1/64 inch or to specifications.

PERFORMANCE ACTIONS:

3.0201 Check blueprint/specifications.

3.0202 Mark center location with prick punch:

a. Check punch for sharpness.
b. Locate intersection of layout lines with point of prick punch.
c. Hole punch in vertical position.
d. Tap lightly with tool maker's hammer or equivalent.

3.0203 Examine punch mark with magnifying glass.

3.0204 Correct punch mark as necessary following recommended procedure (text).

3.0205 Check punch mark with magnifying glass.

3.0206 Center punch hole location for deep mark.

3.0207 Verify hole locations marked against specifications, correcting as necessary.

PERFORMANCE STANDARDS:

- Mark locations with prick punch and center punch to an accuracy of +/- 1/64 inch of specifications.

SUGGESTED INSTRUCTION TIME: 3 Hours

UNIT 3.0 WORK LAYOUT

TASK 3.03 LOCATE HOLES WITH TRANSFER PUNCHES

PERFORMANCE OBJECTIVE:

Given workpiece blueprint/specifications, locate holes in workpiece with transfer instruments. Located holes must meet blueprint specifications.

PERFORMANCE ACTIONS:

3.0301 Check specifications.

3.0302 Place workpiece in holding device.

3.0303 Select transfer tools: (Transfer screws for threaded holes.* Transfer punches for straight holes.)

3.0304 Locate holes on workpiece from template:

a. Clamp template to workpiece for transfer punches.
b. Insert transfer punch in template hole.
c. Tap transfer tool lightly with hammer.
d. Remove template.
e. Center punch marks left by transfer punch (or screw).

3.0305 Verify hole locations against specifications.

PERFORMANCE STANDARDS:

- Locate holes with transfer punches to blueprint specifications.

SUGGESTED INSTRUCTION TIME: 3 Hours

*Orientation to Transfer Screws

UNIT 3.0 WORK LAYOUT

TASK 3.04 LAYOUT HOLE SPACING AND OUTSIDE DIMENSIONS

PERFORMANCE OBJECTIVE:

Given rectangular stock, a dimensioned blueprint/drawing and specifications, combination square, and the necessary layout and scribing tools, measuring instruments, and materials; layout hole spacing and outside dimensions to a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

3.0401 Review blueprints.

3.0402 Layout hole spacing and outside dimensions.

PERFORMANCE STANDARDS:

- Layout hole spacing and outside dimensions according to specifications to +/- 1/64 inch tolerance.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Blueprint reading.
- Layout tools.
- Layout techniques.
- Define cumulative and noncumulative tolerance.

UNIT 3.0 WORK LAYOUT

TASK 3.05 LAYOUT ANGLES

PERFORMANCE OBJECTIVE:

Given rectangular stock, dimensioned blueprint/drawing, specifications, bevel protractor, necessary layout and scribing tools, measuring instruments, and materials; layout angles on the stock to a tolerance of +/- 1 minute.

PERFORMANCE ACTIONS:

3.0501 Review prints.

3.0502 Layout angles using a bevel protractor and scriber.

PERFORMANCE STANDARDS:

- Layout angles using bevel protractor and scriber with an accuracy of +/- 1 minute.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Safety.
- Reading the bevel protractor.
- Procedure for layout angles using the bevel protractor and scriber.

UNIT	3.0	WORK LAYOUT
TASK	3.06	LAYOUT A BOLT CIRCLE

PERFORMANCE OBJECTIVE:

Given pre-cut stock, detailed drawing and specifications, combination square, measuring instruments, and necessary layout and scribing tools; layout a bolt circle on the stock to specifications within +/- 1/64 inch.

PERFORMANCE ACTIONS:

3.0601 Review prints.

3.0602 Layout bolt circle following procedures demonstrated by instructor.

PERFORMANCE STANDARDS:

- Layout a bolt circle on given stock to specifications within +/- 1/64 inch.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Calculate bolt circle coordinates.
- Calculating chordal distances.
- Explain purpose of base line.
- Procedures for laying out a bolt circle.
- Using dividers to mark various radii.

UNIT 3.0 WORK LAYOUT

TASK 3.07 LAYOUT COMPOUND ANGLES

PERFORMANCE OBJECTIVE:

Given pre-cut stock, detailed drawing and specifications, combination square, bevel protractor, measuring instruments, and necessary layout and scribing tools; layout compound angles on stock to specifications with a tolerance of +/- 1 minute.

PERFORMANCE ACTIONS:

3.0701 Review drawings, specifications.

3.0702 Following accepted procedure, layout compound angles using a combination square, bevel protractor, and scriber.

PERFORMANCE STANDARDS:

- Layout compound angles on given stock using combination square, bevel protractor, and scriber and following demonstrated procedures.
- Layout must be to specifications within +/- 1 minute.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Define degree, minute, and compound angle.
- Use of layout tools.
- Procedures for layout of compound angles.

UNIT 3.0 WORK LAYOUT

TASK 3.08 LAYOUT TANGENTS

PERFORMANCE OBJECTIVE:

Given pre-cut stock, detailed drawing and specifications, measuring instruments, combination square, bevel protractor, and necessary layout and scribing tools; layout angles tangent to radii on the stock to specifications within +/- 1 degree.

PERFORMANCE ACTIONS:

3.0801 Review drawing, specifications.

3.0802 Demonstrate proper steps in laying out angles tangent to radii using combination square, bevel protractor, and scriber.

PERFORMANCE STANDARDS:

- Layout angles tangent to radii on stock provided to specifications within a tolerance of +/- 1 degree using the combination square, bevel protractor, and scriber.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Use of combination square, bevel protractor, and scriber.
- Define tangent, vertex, and radius.
- Calculating center dimensions.
- Layout procedures demonstrated by instructor.

UNIT 4.0

BENCHWORK

BENCHWORK TERMINOLOGY

BENCHWORK	Work placed on a bench or in a bench vise for operations usually involving hand tools.
MACHINE WORK	Shop work using machines such as lathes, milling machines, drill presses, saws, and grinders.
FLOOR WORK	Work that cannot be accomplished easily on the bench, but using the same tools as used in benchwork.
HAND TOOLS	Typical benchwork tools include: - Hammers - Vises - Wrenches - Files - Chisles - Punches - Hand taps - Threading dies - Screwdrivers - Measuring tools - Layout tools - Cutting tools - Assembly tools - Inspection tools - Metal stamps - Small drills - Hand reamers - Hand hacksaws
CHIPPING	Producing chip using chisel.
MUSHROOM	Enlarged area on end of chisel, caused by striking it with hammer.
TANG	Pointed end of file.
SHEARING	Cutting action of a tool.
DRAWFILING	Pushing and pulling file sideways along work.
BURR	Sharp edge left on metal part from machining operation.
HARDENING	Process of making metal resistant to wear.
BRITTLE	Easy to break.
REFERENCE SURFACE	Side from which dimensions are taken or made.
LAYOUT DYE	Thin colored lacquer painted or sprayed on surface of part so layout can be seen clearly.

(NOTE: The student should identify each individual hand tool used in benchwork and should describe the primary use of the tool.)

MACHINE SHOP
BENCHWORK
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 4.0	BENCHWORK	
4.01	Inspect Workbench Area for Safe Working Environment	1/2
4.02	Care for Hand Tools	2
4.03	Bench File Workpiece	4
4.04	Disassemble/Assemble Workpiece with Arbor Press	1
4.05	Hand Broach and Internal Keyway	4
4.06	Using Hand Hacksaw, Cut Given Material in Required Time	1
4.07	Cut Threads with Hand Tap	1/2
4.08	Drill Holes with Portable Drill	1/2
4.09	Grind Part with Hand Grinder	1/2
4.10	Hand Hone Cutting Tools	1/2
4.11	Hand Ream Holes	1/2
4.12	Remove Broken Drills and Taps	2
4.13	Remove Damaged/Broken Studs/Screws	4
4.14	Cut Threads with Die	1/2
4.15	File Test Workpiece for Hardness	1/2
4.16	Remove Frozen or Seized Parts	2
4.17	Identify Types of Fasteners	2
4.18	Assemble and Fit Parts	4
4.19	Identify and Properly Use Work-holding Devices and Set-ups	2

4.20	Identify and Properly Use Coolants and Cutting Compounds	2
4.21	Properly Use Hand Tools for Assembly/Disassembly	2
	TOTAL HOURS	37

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 4.0	BENCHWORK
4.01	(Inspect Workbench Area for Safe Working Environment) Using "performance actions" as a checklist, inspect the benchwork area for safe working environment. All unsafe conditions must be reported immediately. All items must be marked safe or corrected to a safe condition.
4.02	(Care for Hand Tools) Given a tool box or set of typical hand tools used in machine shop benchwork, manufacturer's standards concerning proper use and care of hand tools; care for hand tools to manufacturer's or instructor's specifications.
4.03	(Benchwork File Workpiece) Given a workpiece, blueprint or drawing/specifications, and necessary equipment; hand file the workpiece within a tolerance of +/- 1/64 inch on fractional dimensions, +/- 0.005 inch on decimal dimensions, +/- 1 degree on angular dimensions, or within blueprint specifications.
4.04	(Disassemble/assemble Workpiece with Arbor Press) Given a blueprint/drawing or specifications, workpiece, measuring instruments, and an arbor press; remove and replace parts with press to correct tolerance.
4.05	(Hand Broach an Internal Keyway) Given blueprint or drawings, arbor press, workpiece, broaching tools, and necessary equipment; broach workpiece. The workpiece must be within a tolerance of +/- 0.001 inch on decimal dimensions and +/- 1/64 inch on fraction dimensions or meet blueprint specifications.
4.06	(Using Hand Hacksaw, Cut Given Materials in Required Time) Furnished with workpiece and blueprint/drawing/specifications, hacksaw the workpiece in a given time to within 1/32 inch outside of scribed line.
4.07	(Cut Threads with Hand Tap) Furnished with workpiece and blueprint/drawing/specifications, hand tap the necessary tools and materials; hand tap workpiece so it will fit a gage or mating screw.
4.08	(Drill Holes with Portable Drill) Given a workpiece, blueprint/drawing or specifications, portable drill, and the necessary tools and materials; drill the workpiece as required.
4.09	(Grind Part with Hand Grinder) Given a workpiece, blueprint/drawing or specifications, hand grinder with proper wheel or disc; grind workpiece to print specifications.

4.10 (Hand Hone Cutting Tools) Given several cutting tools such as chisels, specifications for sharpening, and abrasive stones; hand sharpen the cutting tools to specifications using proper techniques taught by the instructor.

4.11 (Hand Ream Holes) Using given hand tools, workpiece, and specifications; hand ream hole to specifications or removing approximately .002 - .005 inch from workpiece.

4.12 (Remove Broken Drills and Taps) Remove broken tools from workpiece using bench hand tools provided so that workpiece meets specifications.

4.13 (Remove Damaged/Broken Studs/Screws) Remove damaged/broken screw/stud from workpiece, using given hand tools, and restoring the original tapped hole to specifications.

4.14 (Cut Threads with Die) Given specifications/blueprints, workpiece, bench hand tools and materials; but by hand a thread on the workpiece. The threaded work must be to specifications.

4.15 (File Test Workpiece for Hardness) Given workpiece and files, check workpiece for hardness. Workpiece must be determined as machinable by cutting tools or must be machined by abrasives of carbine tools.

4.16 (Remove Frozen or Seized Parts) Given machine or workpiece with frozen or seized parts, hand tools*, and all necessary information and materials; select proper removal method and remove frozen or seized part without damage to machine or workpiece.

*Tools may include power drill (portable or stand).

4.17 (Identify and Properly Use Coolants and Cutting Compounds) Given coolants used for drilling or reaming, accurately select the appropriate cutting lubricant or compound for a given job, and use the lubricant or compound according to appropriate safe procedure.

4.18 (Assemble and Fit Parts) Given necessary tools and equipment, instructions as necessary, and parts to assemble and fit; make drive, sliding, running and shrink fits according to correct procedures for outside and inside measurements for gears, pulleys, bushings, shafts, spindles, and threads.

4.19 (Identify and Properly use Work-holding Devices and Set-ups) Given a selection of drill press work-holding devices, properly identify each device and demonstrate how to fasten the device to the bench and use it properly.

4.20 (Identify and Properly use Coolants and Cutting Compounds) Given coolants used for drilling or reaming, accurately select the appropriate cutting lubricant or compound for a given job, and use the lubricant or compound according to appropriate safe procedure.

4.21 (Properly use Hand Tools for Assembly/Disassembly) Given machinist's hand tools or tool box, a job requiring use of hand tools, properly select and use basic hand tools including hammers, screwdrivers, wrenches, and pliers.

UNIT	4.0	BENCHWORK
TASK	4.01	INSPECT WORKBENCH AREA FOR SAFE WORKING ENVIRONMENT

PERFORMANCE OBJECTIVE:

Using "performance actions" as a checklist, inspect the bench work area for safe working environment. All unsafe conditions must be reported immediately. All items must be marked safe or corrected to a safe condition.

(OMIT ITEMS NOT APPLICABLE, INDICATING "N/A.")

PERFORMANCE ACTIONS:

4.0101 Inspect area machine tools:

a. Guards/safety devices in place.
b. Control location clear, safe.
c. Power transmission or drive mechanism safe.
d. Overload devices in place, proper value.
e. Ventilation, where applicable, provided.
f. Metal scraps cleaned up.
g. Attachments/accessories available.

4.0102 Hand tools:

a. Stored properly.
b. Not damaged.
c. Clean.
d. Safety devices, where applicable, provided/-attached.

4.0103 Personal protection equipment: (Where applicable)

a. Footwear (no canvas shoes, etc.).
b. Eye protection.
c. Head protection, where applicable.
d. First-aid station provided.
e. Fire extinguisher provided.

4.0104 Safety signs and markings displayed in proper locations and proper color coded markings used for safety.

4.0105 Floors, passageways, aisles, spaces around machines:

a. Clean.
b. Free of oil, grease, or other liquids.
c. Stock not blocking work or passage area.

UNIT 4.0 BENCHWORK

TASK 4.01 INSPECT WORKBENCH AREA FOR SAFE WORKING ENVIRONMENT

PERFORMANCE ACTIONS (Con't.):

d. Non-skid mats or safety mats used where appropriate.

4.0106 Disposal cans:

a. Located in designated, convenient areas.
b. Marked.
c. Covered, if applicable (for greasy, oily rags, etc.).

PERFORMANCE STANDARDS:

- Workbench area inspected for safety, using checklist provided.

SUGGESTED INSTRUCTION TIME: 1/2 Hour
(3-5 Minutes maximum, after initial orientation)

UNIT 4.0 BENCHWORK

TASK 4.02 CARE FOR HAND TOOLS

PERFORMANCE OBJECTIVE:

Given a tool box or set of typical hand tools used in machine shop benchwork, manufacturer's standards concerning proper use and care of hand tools; care for hand tools to manufacturer's or instructor's specifications.

PERFORMANCE ACTIONS:

4.0201 Inspect hand tools and determine damage, if any:

a. Cutting tools must be sharp with no broken teeth.
b. Clamping tools must have clean jaws and screws.
c. Soft jaws must be available for vises.
d. Screwdrivers must have correctly shaped blades.
e. Punches and chisels must not have mushroomed heads.

4.0202 Obtain any needed parts:

a. Dismantle and replace damaged parts.
b. Make required adjustments.

4.0203 Sharpen dull tools:

a. Check for mushroomed heads.
b. Check angle of cutting edge.
c. Regrind shape as required.

PERFORMANCE STANDARDS:

- For given hand tools, demonstrate proper use and care of hand tools such as pliers, screwdrivers, wrenches, striking and struck tools to the manufacturer's or instructor's standards.

(NOTE: Most typical benchwork hand tools are covered in the following publication which may be referred to for standards:

Proper Use and Care of Hand Tools, Pliers, Screwdrivers, Wrenches, Striking & Struck Tools, Chicago, IL: Klein Tools, Inc., 1977. (Available free in quantities to vocational programs.)

UNIT 4.0 BENCHWORK

TASK 4.02 CARE FOR HAND TOOLS (Con't.)

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Manufacturer's standards concerning care for hand tools.
- Instructor's standards for care of shop tools.
- Safety.

UNIT 4.0 BENCHWORK

TASK 4.03 BENCH FILE WORKPIECE

PERFORMANCE OBJECTIVE:

Given a workpiece, blueprint or drawing/specifications, and necessary equipment; hand file the workpiece within a tolerance of +/- 1/64 inch on fractional dimensions, +/- 0.005 inch on decimal dimensions, +/- 1 degree on angular dimensions, or within blueprint specifications.

PERFORMANCE ACTIONS:

4.0301 Review specifications.

4.0302 Select proper file.

4.0303 Check file handle or install handle on file.

4.0304 Clean file, if necessary (file should have been cleaned prior to storage in toolroom/box).

4.0305 Mount workpiece (elbow high for general filing).

4.0306 Test flatness or angle or work.

4.0307 Check for pinning (condition of file and chalk).

4.0308 File to final tolerance repeating steps 6 and 7 as required:

a. Avoid allowing file to rock or see-saw which might produce a crowned surface.
b. Use flat filing or draw filing techniques as appropriate.

4.0309 Upon completion of job task, clean file and return it to toolroom/box.

PERFORMANCE STANDARDS:

- Hand file workpiece within a tolerance of +/- 1/64 inch on fractional dimensions, +/- 0.005 inch on decimal dimensions, +/- 1 degree on angular dimensions, or within blueprint specifications.
- File should be held in a safe manner, flat so it does not rock or see-saw, and used in a procedure recommended by the instructor.
- Performance process and product must be to instructor's standards.

UNIT 4.0 BENCHWORK

TASK 4.03 BENCH FILE WORKPIECE (Con't.)

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- File patterns, cuts of files: Single, double, rasp, and curved.
- Straightforward, flat, draw, and round-corner filing.
- Use of the file card and care of files.
- Safety with files.
- Techniques of hand filing: Instructor's standards.
- Measuring instruments.
- Use of bench vise.

FILING STANDARDS:

- A TRIANGULAR file may be used on acute internal angles and to clear out corners. It can also be used to sharpen saw teeth.
- A MILL file is used in smoothing lathe work as well as draw filing and other precision work. Mill files are always single cut types.
- A FLAT file is used for general purpose work. Choose coarse or bastard files for rough work and second cut or smooth files for finish filing.
- A SQUARE file may be used to enlarge rectangle shaped holes or slots.
- A HALF ROUND file is used with a range of different jobs: The flat side may be used on flat surface filing while the rounded side may be used for filing curved surfaces.
- The SWISS PATTERN file may be used when delicate filing is needed such as with precision parts.

UNIT 4.0 BENCHWORK

TASK 4.04 DISASSEMBLE/ASSEMBLE WORKPIECE WITH ARBOR PRESS

PERFORMANCE OBJECTIVE:

Given a blueprint/drawing or specifications, workpiece, measuring instruments, and an arbor press; remove and replace parts with press to correct tolerance.

PERFORMANCE ACTIONS:

4.0401 Set up work:

a. Record measurements of position of workpiece parts to be removed.
b. Place and clamp stationary part of arbor table/press.
c. Align movable part with arbor ram.

4.0402 Remove part:

a. Lubricate both parts, if applicable.
b. Check for keys, set screws and tapers or shoulders.
c. Apply pressure to remove part, if appropriate.
d. Remove part with care not to damage workpiece.

4.0403 Replace part:

a. Lubricate both parts, if applicable.
b. Check assembly procedures.
c. Align keyways or matching parts as applicable.
d. Press parts together with arbor press.
e. Check tolerance.

PERFORMANCE STANDARDS:

- Using arbor press, disassemble/assemble workpiece parts according to specifications with correct tolerance.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Measurement.
- Safety.

UNIT 4.0 BENCHWORK

TASK 4.05 HAND BROACH AN INTERNAL KEYWAY

PERFORMANCE OBJECTIVE:

Given blueprint or drawings, arbor press, workpiece, broaching tools, and necessary equipment; broach workpiece. The workpiece must be within a tolerance of +/- 0.001 inch on decimal dimensions and +/- 1/64 inch on fraction dimensions or meet blueprint specifications.

PERFORMANCE ACTIONS:

4.0501 Review blueprint, drawing, specifications.

4.0502 Mount work and supports on arbor press.

4.0503 Select broaching tool and guide.

4.0504 Align broaching tool on workpiece:

  a. Check ram wear on arbor press.
  b. Check vertical alignment of broaching tool.

4.0505 Press broaching tool through workpiece to produce internal keyway:

  a. Use lubricant except on cast iron.
  b. Repeat cut with shim if necessary.

4.0506 Check measurement of workpiece, accepting or taking corrective actions.

4.0507 File to remove cutting burrs from edges of keyway.

4.0508 Return tools to proper locations after proper cleaning/care.

PERFORMANCE STANDARDS:

- Using arbor press, hand broach workpiece to specifications +/- 0.001 inch on decimal dimensions and +/- 1/64 inch on fraction dimensions or meet blueprint specifications.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Describe how to set up and use arbor press.
- Explain hand broaching.
- Use of precision shims.
- Safety.
- Filing to remove cutting burrs from edges of keyway.

UNIT 4.0 BENCHWORK

TASK 4.06 USING HAND HACKSAW, CUT GIVEN MATERIAL IN REQUIRED TIME

PERFORMANCE OBJECTIVE:

Furnished with workpiece and blueprint/drawing/specifications, hacksaw; hacksaw the workpiece in a given time to within 1/32 inch outside of scribed line.

PERFORMANCE ACTIONS:

4.0601 Review job blueprint/drawing/specifications.

4.0602 Select hacksaw and blade.

4.0603 Properly mount blade in hacksaw frame.

4.0604 Mount workpiece in holding device such as vise.

4.0605 Using correct technique saw workpiece to specifications:

a. Scribe workpiece for cut.
b. Notch workpiece with file for start of cut.
c. Protect workpiece from jaws of holding device.
d. Saw 1/32 inch outside of scribed line.

4.0606 Deburr when finished.

PERFORMANCE STANDARDS:

- Using hand hacksaw, cut given material, such as angle iron, in the required time, within 1/32 inch outside of scribed line, meeting the instructor's standards for use and care of hacksaw.

SUGGESTED INSTRUCTION TIME: 1 Hours

UNIT 4.0 BENCHWORK

TASK 4.06 USING HAND HACKSAW, CUT GIVEN MATERIAL IN REQUIRED TIME (Con't.)

RELATED TECHNICAL INFORMATION:

- Identify hand hacksaw parts, design.
- Identify types of materials which may be cut by hand handsaw.
- Identify types of blades which may be used with hacksaw (14, 18, 24, 32 teeth and typical uses).
- Identify when and how to mount more than one blade on hacksaw.
- Describe-demonstrate proper technique in using hacksaw.
- Safety with hacksaw.

UNIT 4.0 BENCHWORK

TASK 4.07 CUT THREADS WITH HAND TAP

PERFORMANCE OBJECTIVE:

Furnished with workpiece and blueprint/drawing/specifications, hand tap and necessary tools and materials; hand tap workpiece so it will fit a gage or mating screw.

PERFORMANCE ACTIONS:

4.0701 Review specifications, etc.

4.0702 Secure workpiece in holding device.

4.0703 Locate hole position and center punch.

4.0704 Select tap drill and drill hole:

- a. Consult reference tables.
- b. Clamp work in holding device.

4.0705 Select tap and wrench:

- a. Clamp tap in holder.
- b. Select starter tap.

4.0706 Tap hole to print specifications:

- a. Use lubricant, as required.
- b. Deburr hole (countersink to thread depth).
- c. Start tap in hole.
- d. Check alignment with square.
- e. Turn about 1/8 revolution (RH threads).
- f. Back up slightly to break chips (about each half turn).
- g. Tap hole through and clean out hole.
- h. For blind hole, clean out more than once.
- i. Use plug tap finish, if applicable.

4.0707 Verify tapped hole with gage or mating screw and specifications.

4.0708 Clean/care for and return tools to proper locations.

PERFORMANCE STANDARDS:

- Cut threads with head tap so it will fit gage or mating screw depth or meet specifications.
- Performance process (techniques) and product must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Bench safety.
- Tap drill sizes.
- Use of drill charts.
- Use of oil cutting, fluid.
- Techniques of using hand tap to cut threads.
- Use and care of bench tools and equipment.
- Identify sizes and types of screw threads.
- Mounting workpiece in holding device.
- Checking tap for squareness.

UNIT 4.0 BENCHWORK

TASK 4.08 DRILL HOLES WITH PORTABLE DRILL

PERFORMANCE OBJECTIVE:

Given a workpiece, blueprint/drawing or specifications, portable drill, and the necessary tools and materials; drill the workpiece as required.

PERFORMANCE ACTIONS:

4.0801 Review specifications.

4.0802 Locate and center punch in workpiece.

4.0803 Mount workpiece in holding device.

4.0804 Select drill:

  a. Check size (with drill gage, etc.).
  b. Check sharpness.

4.0805 Mount drill bit in portable drill and properly tighten bit in chuck.

4.0806 Drill hole in workpiece:

  a. Observe safety procedures.
  b. Hold drill perpendicular to workpiece.
  c. Run drill at proper speed, if adjustable.
  d. Reduce feed pressure as drill penetrate workpiece.
  e. Deburr hole.

4.0807 Verify drilled hole.

4.0808 Clean/care for tools and return them to proper storage.

PERFORMANCE STANDARDS:

- Drill holes with portable drill as required meeting instructor's standards for performance process and product.

SUGGESTED INSTRUCTION TIME: 1/2 Hours

UNIT 4.0 BENCHWORK

TASK 4.08 DRILL HOLES WITH PORTABLE DRILL (Con't.)

RELATED TECHNICAL INFORMATION:

- Safety.
- Selection of drill bits.
- Use of portable drill.
- Alignment of drill/bit with workpiece.
- Electrical safety (portable power drill).

UNIT 4.0 BENCHWORK

TASK 4.09 (Optional*) GRIND PART WITH HAND GRINDER

PERFORMANCE OBJECTIVE:

Given a workpiece, blueprint/drawing or specifications, hand grinder with proper wheel or disc; grind workpiece to print specifications.

PERFORMANCE ACTIONS:

4.0901 Review specifications.

4.0902 Mount workpiece in working-holding device.

4.0903 Select grinding wheel or disc:

- a. Check speed of grinder, if applicable.
- b. Check type of finish required.
- c. Check chuck size or grinder.

4.0904 Mount grinding wheel on grinder.

4.0905 Grind workpiece:

- a. Follow safety precautions.
- b. Use proper guard on wheel, as applicable.

4.0906 Check ground surface and measure workpiece.

PERFORMANCE STANDARDS:

- Grind workpiece with hand (power) grinder to print specifications.

SUGGESTED INSTRUCTION TIME: 1/2 Hours

RELATED TECHNICAL INFORMATION:

- Safety.
- Use of hand grinder.
- Measuring instruments.
- Selection of grinding wheels/disc.
- Techniques of using hand grinder.

*If tool available, and if time permits.

UNIT 4.0 BENCHWORK

TASK 4.10 HAND HONE CUTTING TOOLS

PERFORMANCE OBJECTIVE:

Given several cutting tools such as chisels, specifications for sharpening, and abrasive stones; hand sharpen the cutting tools to specifications using proper techniques taught by the instructor.

PERFORMANCE ACTIONS:

4.1001 Assemble tools to be sharpened.

4.1002 Select oilstone.

4.1003 Hone one face of cutting edge:

a. Use medium/fine abrasive stone.
b. Apply lubricant.
c. Hold face of tool flat on surface of oilstone.
d. Slide stone across face of tool, back and forth.
e. Finish surface on fine abrasive side.

4.1004 Repeat steps 2-3 as required to meet specifications.

PERFORMANCE STANDARDS:

- Hand sharpen cutting tools to specifications using abrasive stones.
- Performance process and product must meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Safety.
- Techniques for redressing cutting tools.
- Maintaining proper cutting angle of tool.

UNIT 4.0 BENCHWORK

TASK 4.11 HAND REAM HOLES*

PERFORMANCE OBJECTIVE:

Using given hand tools, workpiece, and specifications; hand ream hole to specifications or removing approximately .002 - .005 inch from workpiece.

PERFORMANCE ACTIONS:

4.1101 Review specifications.

4.1102 Secure workpiece in holding device.

4.1103 Select reamer.

4.1104 Mount reamer in tap wrench.

4.1105 Ream holes using proper techniques:

a. Check squareness with workpiece.
b. Use lubricant where applicable.
c. Turn clockwise direction only.
d. Use slight downward pressure.

PERFORMANCE STANDARDS:

- Hand ream holes using given materials and specifications meeting instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour*

RELATED TECHNICAL INFORMATION:

- Safety.
- Hand reaming with drill press.
- Checking size of reamer with micrometer.
- Removing reamer from hole: Care of reamer tool.
- Lining up reamer, checking for alignment.
- Use of cutting fluid.

*If tool available.

UNIT 4.0 BENCHWORK

TASK 4.12 REMOVE BROKEN DRILLS AND TAPS

PERFORMANCE OBJECTIVE:

Remove broken tools from workpiece using bench hand tools provided so that workpiece meets specifications.

PERFORMANCE ACTIONS:

4.1201 ACTIONS TO REMOVE BROKEN TAP:

(1) Check specifications.
(2) Select tap extractor (if available):
    a. Note number of flutes.
    b. Check fingers of extractor.
(3) Remove broken tap:
    a. Check RH and LH threads.
    b. If tap extends above workpiece surface, use pliers to remove tap.
    c. Extend fingers completely into flutes.
    d. Slide sleeve down against workpiece.
    e. Use lubricant, as necessary.
    f. Watch for fractured pieces.
    g. Work tap back and forth with removal.
(4) Clean out tapped hole and retap.

4.1202 ACTIONS TO REMOVE BROKEN DRILL:

(1) Check size of broken drill.
(2) Use pliers, if possible to lift and twist out drill.
(3) If applicable, drive out drill with pin punch. (May be applicable to broken tap also.)
(4) Anneal drill bit out if it will not damage workpiece.

PERFORMANCE STANDARDS:

- Remove broken drills and taps, restring workpiece to specifications without damage.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT	4.0	BENCHWORK
TASK	4.12	REMOVE BROKEN DRILLS AND TAPS (Con't.)

RELATED TECHNICAL INFORMATION:

- Avoiding damage to internal threads and extractor.
- Safety.

UNIT 4.0 BENCHWORK

TASK 4.13 REMOVE DAMAGED/BROKEN STUDS/SCREWS

PERFORMANCE OBJECTIVE:

Remove damaged/broken screw/stud from workpiece, using given hand tools, and restoring the original tapped hole to specifications.

PERFORMANCE ACTIONS:

4.1301 Secure workpiece in holding device.

4.1302 Center punch damaged screw.

4.1303 Center drill damaged screw.

4.1304 Check thread for RH and LH.

4.1305 Select drill and screw extractor.

4.1306 Remove damaged screw:

a. Insert screw extractor in drilled hole.
b. Turn gently using downward force.
c. Apply lubricant around threads.
d. Turn counter clockwise (RH threads) (Reverse for LH).

4.1307 Clean hole and rethread with tap to original specifications.

PERFORMANCE STANDARDS:

- Remove damaged/broken studs/screws using given bench tools and restoring original tapped hole to specifications.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Proper use of screw extractor, ease outs.
- Removing screws by heating and allowing them to cool and shrink.
- Benchwork "hints and kinks" from instructor.
- Safety.

UNIT	4.0	BENCHWORK
TASK	4.14	CUT THREADS WITH DIE

PERFORMANCE OBJECTIVE:

Given specifications/blueprints, workpiece, bench hand tools and materials; cut by hand a thread on the workpiece. The threaded work must be to specifications.

PERFORMANCE ACTIONS:

4.1401 Check blueprint/specifications for size and length of thread.

4.1402 Select die and die stock.

4.1403 Prepare workpiece for threading:

a. Grind or bevel on the end.
b. Grind or machine to 0.003 - 0.005 inch undersize.
c. Mount workpiece in holding device.
d. Mark off length of thread.

4.1404 Thread workpiece with die:

a. Use lubricant.
b. Start on chamfered part of die.
c. Start and hold die square with workpiece.
d. Press down and turn 1/8 revolution, then back up one-half turn.
e. Check with gage or mating part after a few threads are made.
f. Adjust die as necessary.
g. If threads run to shoulder, reverse die on workpiece and thread to shoulder.

4.1405 Check workpiece (thread ring gage).

4.1406 Assure workpiece within/without specified tolerances rejecting workpiece that cannot be correct to specifications.

PERFORMANCE STANDARDS:

- Cut threads with die using bench hand tools so that work is to specifications.
- Performance process and product must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Use of GO/NO GO thread ring gage (if available) [orientation to GO/NO GO, if not available].
- Safety.
- Squaring die to work.
- Proper techniques of cutting thread with die.

UNIT 4.0 BENCHWORK

TASK 4.15 FILE TEST WORKPIECE FOR HARDNESS

PERFORMANCE OBJECTIVE:

Given workpiece and files, file test workpiece for hardness. Workpiece must be determined as machinable by cutting tools or must be machined by abrasives or carbine tools.

PERFORMANCE ACTIONS:

4.1501 Select fine 3 cornered file.

4.1502 Test workpiece with file:

a. Use corner of workpiece, if possible.
b. File on workpiece at non-critical point, if possible.

4.1503 Determine hardness of work.

4.1504 Decide on machinability of workpiece.

PERFORMANCE STANDARDS:

- Test workpiece for hardness without hardness tester.
- Finding must be in agreement with instructor's finding.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Safety.
- Use of files.
- Orientation to metals.
- Orientation to hardness testing (no skill taught).
- Demonstrate:
  a. Scratch test: Hardness of two metals.
  b. Magnet test: Ferrous from nonferrous metals.
  c. File test: (1) Mild steel
  (2) Hardened tool steel

UNIT 4.0 BENCHWORK

TASK 4.16 REMOVE FROZEN OR SEIZED PARTS

PERFORMANCE OBJECTIVE:

Given machine or workpiece with frozen or seized parts, hand tools*, and all necessary information and materials; select proper removal method and remove frozen or seized part without damage to machine or workpiece.

*Tools may include power drill (portable or stand).

PERFORMANCE ACTIONS:

4.1601 Decide on proper removal method:

a. Drive part out.
b. Drill out part.
c. Drill and use screw extractor.
d. Press out part.
e. Heat part.

4.1602 Soak seized part with penetrating oil.

4.1603 Check for set screws and pins holding part.

4.1604 Check for taper and shoulders.

4.1605 After removing part, verify condition of machine or workpiece, and if corrective actions does not restore it to specifications, reject the repair.

PERFORMANCE STANDARDS:

- Remove frozen/seized parts using bench tools and drills without damaging the machine or workpiece.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 4.0 BENCHWORK

TASK 4.17 IDENTIFY TYPES OF FASTENERS

PERFORMANCE OBJECTIVE:

Given a random selection of typical fasteners the machinist will encounter, identify each fastener and its typical application.

PERFORMANCE ACTIONS:

4.1701 Identify fasteners:

- a. Bolts.
- b. Screws.
- c. Nuts.
- d. Studs.
- e. Washers.
- f. Internal threaded inserts.
- g. Rivets.
- h. Pins: Cotter, Dowel, Taper, Split dowel.
- i. Retaining fasteners: Rings.
- j. Keys: Square, Woodruff, Pocket, Taper.

4.1702 Identify typical uses of fasteners.

PERFORMANCE STANDARDS:

- Identify types of fasteners common to machine benchwork and their typical uses to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.
- American Machinist's Handbook.
- Commercial Supply Catalogs.

UNIT 4.0 BENCHWORK

TASK 4.18 ASSEMBLE AND FIT PARTS

PERFORMANCE OBJECTIVE:

Given necessary tools and equipment, instructions as necessary, and parts to assemble and fit; make drive, sliding, running and shrink fits according to correct procedures for outside and inside measurements for gears, pulleys, bushings, shafts, spindles, and threads.

PERFORMANCE ACTIONS:

4.1801 Make following types of fits:

a. Drive.
b. Sliding.
c. Running.
d. Shrink.

PERFORMANCE STANDARDS:

- Assemble and fit parts correctly.

(NOTE: Orientation training: Competency will be developed through practice and experience.)

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.
- Standard shafting.
- Tolerances.
- Procedures for making a press fit.
- Types of fits:
  a. Loose.
  b. Free.
  c. Medium.
  d. Snug.
  e. Wringing.
  f. Tight.
  g. Heavy force and shrink.

UNIT 4.0 BENCHWORK

TASK 4.19 IDENTIFY AND PROPERLY USE WORK-HOLDING DEVICES AND SET-UPS

PERFORMANCE OBJECTIVE:

Given a selection of drill press work-holding devices, properly identify each device and demonstrate how to fasten the device to the bench and use it properly.

PERFORMANCE ACTIONS:

4.1901 Identify purpose of work-holding devices:

Identify methods:

a. T-bolts and clamps.
b. Parallels.
c. C-clamps.
d. Angle plates.
e. Drill press vises.
f. Cold finished key stock.
g. V-blocks.

4.1902 Demonstrate proper method of using work-holding devices.

PERFORMANCE STANDARDS:

- Properly identify and demonstrate how to use work-holding devices and set-ups to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Safety.

UNIT 4.0 BENCHWORK

TASK 4.20 IDENTIFY AND PROPERLY USE COOLANTS AND CUTTING COMPOUNDS

PERFORMANCE OBJECTIVE:

Given coolants used for drilling or reaming, accurately select the appropriate cutting lubricant or compound for a given job, and use the lubricant or compound according to appropriate safe procedure.

PERFORMANCE ACTIONS:

4.2001 Identify:

a. Cutting oils.
b. Cutting compounds.
c. Advantages of using oils and compounds.
d. Using turpentine.
e. Reclaiming cutting oils.
f. Selecting coolant formula.
g. How to use a cutting compound.
h. Use of cutting compounds for cast iron.
i. Use of cutting compounds for brass and aluminum.

4.2002 Use a cutting compound in a given job.

PERFORMANCE STANDARDS:

- Select and properly use coolants and cutting compounds in given jobs.
- Selection and use must meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.
- American Machinist's Handbook.

UNIT 4.0 BENCHWORK

TASK 4.21 PROPERLY USE HAND TOOLS FOR ASSEMBLY/DISASSEMBLY

PERFORMANCE OBJECTIVE:

Given machinist's hand tools or tool box, a job requiring use of hand tools, properly select and use basic hand tools including hammers, screwdrivers, wrenches, and pliers.

PERFORMANCE ACTIONS:

4.2101 Properly select and demonstrate use and care of ball peen hammer, machinist's hammer, and other striking tools as required:

- a. Identify main parts of the machinist's hammer.
- b. Hammer safety.
- c. Types of hammers and handles.

4.2102 Properly select and demonstrate use and care of screwdrivers:

- a. Identify basic types of screwdrivers.
- b. Choose a screwdriver for a given job.

4.2103 Properly select a wrench for a given job:

- a. Identify Types:
    - open end
    - box end
    - adjustable
    - spanner
- b. Demonstrate proper method of using wrenches:
    - safety
    - leverage
    - checking nut tightness

4.2104 Properly select and use pliers for benchwork:

- a. Identify major types of pliers.
- b. Demonstrate proper use and care of pliers.

PERFORMANCE STANDARDS:

- Properly use and care for hand tools for assembly/disassembly.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 4.0 BENCHWORK

TASK 4.21 PROPERLY USE HAND TOOLS FOR ASSEMBLY/DISASSEMBLY (Con't.)

RELATED TECHNICAL INFORMATION:

- Care of hand tools.
- Safety.

UNIT 5.0

BASIC GRINDING
(BENCH AND PEDESTAL GRINDERS)

Basic grinding introduces the student to the bench and pedestal grinders, to grinder safety, and to the different types of grinding wheels. Through practical experience tasks, the student will develop minimum skills for entry level employment including bench and pedestal grinder set-ups, operation, and maintenance.

MACHINE SHOP
BASIC GRINDING
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 5.0	BASIC GRINDING	
5.01	Set-up Pedestal Grinder	3
5.02	Inspect and Clean a Pedestal Grinder	1/2
5.03	Grind a Convex Radius	2 1/2
5.04	Grind a Center Punch	1
5.05	Sharpen a Chisel	2
5.06	Sharpen Drill Bits by Hand	6
5.07	Grind a General-purpose Turning Tool Bit	6
	TOTAL HOURS	21

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 5.0	BASIC GRINDING
5.01	(Set-up Pedestal Grinder) Given a pedestal grinder requiring set-ups for a grinding dressing, an operator's manual or equivalent, and the necessary tools, equipment, and materials; set-up the pedestal grinder and mount, true, and dress the grinding wheel for a grinding job. The grinding wheel must run true, and the grinding surface must not be loaded or glazed. The pedestal grinder must operate according to manufacturer's specifications.
5.02	(Inspect and Clean a Pedestal Grinder) Given an operator's manual or equivalent, cleaning materials, and the necessary hand tools; inspect and clean a pedestal grinder according to the manufacturer's recommended procedures. The grinder and surrounding area must be free of metal chips, excess lubricant, and foreign material.
5.03	(Grind a Convex Radius) Given a pedestal grinder, workpiece, grinding and wheel dressing specifications, a wheel dresser, radius and fillet gages, and the necessary tools and materials; hand grind a convex radius on the workpiece to specifications +/- 1/64 inch.
5.04	(Grind a Center Punch) Using a pedestal grinder, a center punch, bevel protractor, and the necessary tools and materials; hand grind the center punch. The punch must be ground to an included angle as with a tolerance of +/- 5 degrees.
5.05	(Sharpen a Chisel) Using the pedestal grinder, bevel protractor, and the necessary tools and materials; hand grind a given chisel with unserviceable point. The point must be ground to an included angle of 65 degrees with a tolerance of +/- 5 degrees.
5.06	(Sharpen Drill Bits by Hand) Using the pedestal grinder, medium- or fine-grade wheel mounted on grinder, drills bits to sharpen, drill point gauge or device for measuring angles, and other materials needed; sharpen a drill bit by offhand grinding procedure. The drill point should have a 118 degree angle with 8-12 degree lip clearance.

5.07 (Grind a General-purpose Turning Tool Bit) Given a pedestal grinder, proper type of grinding wheel for tool bit, tool bit(s), tool bit gage, oilstone, and other materials needed; hand grind (sharpen) a general-purpose tool bit. Shape and dimensions of general-purpose tool bit will be to standards of industry.

UNIT 5.0 BASIC GRINDING

TASK 5.01 SET-UP PEDESTAL GRINDER

PERFORMANCE OBJECTIVE:

Given a pedestal grinder requiring set-up for a grinding operation, a grinding wheel requiring mounting, truing, and dressing, an operator's manual or equivalent, and the necessary tools, equipment, and materials; set-up the pedestal grinder and mount, true, and dress the grinding wheel for a grinding job. The grinding wheel must run true, and the grinding surface must not be loaded or glazed. The pedestal grinder must operate according to manufacturer's specifications.

PERFORMANCE ACTIONS:

5.0101 Review manufacturer's instruction manual or equivalent.

5.0102 Assemble required materials, tools, and equipment.

5.0103 Select proper grinding wheel for job and inspect.

5.0104 Ring-test grinding wheel prior to mounting.

5.0105 Mount, true, and dress grinding wheel.

5.0106 Set-up pedestal grinder for required operation.

5.0107 Operate pedestal grinder in a safe and proper manner.

5.0108 Perform grinding operation to specifications.

PERFORMANCE STANDARDS:

- Set-up pedestal grinder according to instructions given; mount, true, and dress wheel; and demonstrate proper use of pedestal grinder.
- The grinding wheel must run true, and the grinding surface must not be loaded or glazed.
- The pedestal grinder must operate according to manufacturer's specifications.
- Process performance must be instructor's standards.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Identify:

a.	Pedestal	e.	Tool rest
b.	Motor	f.	Wheel guard
c.	Grinding wheel	g.	Coolant reservoir
d.	Safety shield	h.	Power switch

- Identify grinding wheel defects.
- Selection of proper grinding wheel for job.
- Procedures for setting up pedestal grinder demonstrated by instructor.
- Basic uses of pedestal grinder.
- Selection of coolant used for wet grinding.
- Proper use of tool rest and wheel guard.
- Safety with the pedestal grinder.
    - "Don't stand in front of grinding wheel: Stand to one side for about a minute as wheel is turned on in case wheel disintegrates."
    - "Use vise-grips to hold work: Not pliers."

UNIT 5.0 BASIC GRINDING

TASK 5.02 INSPECT AND CLEAN A PEDESTAL GRINDER

PERFORMANCE OBJECTIVE:

Given an operator's manual or equivalent, cleaning materials, and the necessary hand tools; inspect and clean a pedestal grinder according to the manufacturer's recommended procedures. The grinder and surrounding area must be free of metal chips, excess lubricant, and foreign material.

PERFORMANCE ACTIONS:

5.0201 Review instructions.

5.0202 Assemble cleaning materials.

5.0203 Inspect and clean the pedestal grinder following outlined procedures.

5.0204 Inspect the pedestal grinder for cleanliness and safety.

5.0205 Clean around the pedestal grinder as appropriate.

PERFORMANCE STANDARDS:

- Inspect and clean a pedestal grinder according to manufacturer's recommended procedures and clean surrounding area as appropriate.
- Process performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Safety.
- Identify proper materials used to clean a pedestal grinder.

UNIT 5.0 BASIC GRINDING

TASK 5.03 GRIND A CONVEX RADIUS

PERFORMANCE OBJECTIVE:

Given a pedestal grinder, workpiece, grinding and wheel dressing specifications, a wheel dresser, radius and fillet gauges, and the necessary tools and materials; hand grind a convex radius on the workpiece to specifications +/- 1/64 inch.

PERFORMANCE ACTIONS:

5.0301 Review job specifications.

5.0302 Assemble tools and materials.

5.0303 Grind a convex radius.

PERFORMANCE STANDARDS:

- Grind a convex radius on a given workpiece to specifications +/- 1/64 inch using the pedestal grinder.

SUGGESTED INSTRUCTION TIME: 2 1/2 Hours

RELATED TECHNICAL INFORMATION:

- Differential convex and concave.
- How to dress a convex radius on a grinding wheel.
- Proper procedure for dressing a convex radius on a grinding wheel.
- Use of fillet gauges.
- Proper steps in grinding a convex radius (demonstrated by instructor).
- Safety.

UNIT 5.0 BASIC GRINDING

TASK 5.04 GRIND A CENTER PUNCH

PERFORMANCE OBJECTIVE:

Using a pedestal grinder, a center punch, bevel protractor, and the necessary tools and materials; hand grind the center punch. The punch must be ground to an included angle as with a tolerance of +/- 5 degrees.

PERFORMANCE ACTIONS:

5.0401 Assemble tools and materials.

5.0402 Hand grind a center punch to recommended angle.

5.0403 Check angle with protractor, and correct grinding as necessary.

PERFORMANCE STANDARDS:

- Hand grind center punch to recommended included angle, +/- 5 degrees.
- Meet instructor's process and performance standards.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Identify various types of punches.
- Demonstrate proper use of bevel protractor.
- Proper procedure for hand grinding a center punch as demonstrated by instructor.
- Center angle for redressing punches (Explain included angle).
- Prick punches redressed to an included angle of about 30 degrees.

UNIT 5.0 BASIC GRINDING

TASK 5.05 SHARPEN A CHISEL

PERFORMANCE OBJECTIVE:

Using the pedestal grinder, bevel protractor, and the necessary tools and materials; hand grind a given chisel with unserviceable point. The point must be ground to an included angle of 65 degrees with a tolerance of +/- 5 degrees.

PERFORMANCE ACTIONS:

5.0501 Identify type of chisel.

5.0502 Sharpen chisel according to proper procedures demonstrated by instructor:

a. Grind flat surfaces, square.
b. Grind angular surface, checking angle with protractor, adjusting work as required.

PERFORMANCE STANDARDS:

- Sharpen a machinist's chisel as required, hand grinding an included angle of about 65 degrees +/- 5 degrees.
- Performance process and product must meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify chisels.
- Identify typical included angles: Cape and Round Nose or Diamond Point.
- Safety.

UNIT 5.0 BASIC GRINDING

TASK 5.06 SHARPEN DRILL BITS BY HAND

PERFORMANCE OBJECTIVE:

Using the pedestal grinder, medium- or fine-grade wheel mounted on grinder, drill bits to sharpen, drill point gauge or device to measure angles, and other materials needed; sharpen a drill bit by offhand grinding procedure. The drill point should have a 118 degree angle with 8-12 degree lip clearance.

PERFORMANCE ACTIONS:

5.0601 Set up pedestal grinder for offhand grinding and assemble drill bits to sharpen. Wear safety glasses.

5.0602 Examine periphery of grinding wheel: Dress wheel as necessary.

5.0603 Adjust tool rest: No further than 1/16 inch from wheel face.

5.0604 Hold drill bit: One hand to tool rest holding drill near the point. Other hand holding drill shank.

5.0605 Rotate drill so cutting edge is approximately 59 degrees to wheel face.

5.0606 Hold lip of drill parallel to grinder tool rest.

5.0607 Bring lip of drill against revolving grinding wheel and slowly lower drill shank: Do not rotate drill.

5.0608 Without moving hands, move drill from wheel, turn it one-half turn, and grind other lip of drill.

5.0609 Check angles and lengths of both lips with the drill point gauge.

5.0610 Repeat steps until cutting lips are sharp and margins are free from wear.

PERFORMANCE STANDARDS:

- Sharpen drill bits (general purpose drill point) by offhand grinding procedure. The drill bit point should have a 118 degree point angle with 8-12 degree lip clearance.

PERFORMANCE STANDARDS (Con't.):

- The drill bit must be sharp, with wear removed, and should check acceptable with the drill point gauge.
- Performance process and product must meet the instructor's standards.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Use of the pedestal grinder.
- Use of the drill press.
- Drill reconditioning.
- Sharpening a carbide drill.
- Safety.

UNIT 5.0 BASIC GRINDING

TASK 5.07 GRIND A GENERAL-PURPOSE TURNING TOOL BIT

PERFORMANCE OBJECTIVE:

Given a pedestal grinder, proper type of grinding wheel for tool bit, tool bit(s), tool bit gage, oilstone, and other materials needed; hand grind (sharpen) a general-purpose tool bit. Shape and dimensions of general-purpose tool bit will be to standards of industry (interpreted by instructor).

PERFORMANCE ACTIONS:*

5.0701 Grasp tool bit firmly, supporting hands on tool rest holder.

5.0702
a. Adjust position of tool bit blank and grind cutting edge angle.
b. Tilt (at same time as action above) bottom of tool bit in and grind 10 degree side-relief angle.

5.0703 Continue grinding until side cutting edge is approximately 1/2 inch long and the point is approximately 1/4 inch the width of tool bit.

(Cool toolbit in water to prevent overheating.)

5.0704 Grind end cutting edge so it forms an angle of less than 90 degrees with the side cutting edge. Form the end-relief angle of 15 degrees at same time.

5.0705 Hold tool bit so it is about 45 degrees to axis of wheel, tilt bottom of tool bit in so side rake of about 14 degrees is ground on top of tool bit.

5.0706 Round point slightly, retaining same end- and side-relief angles.

5.0707 Hone cutting edge and point of tool bit with oilstone.

5.0708 Use tool bit gage to check end- and side-relief angles.

*Performance actions taken from:
Krar, S. F., and J. W. Oswald, Turning Technology, Albany, NY: Delmar Publishers, Inc. pp. 42-47.

UNIT 5.0 BASIC GRINDING

TASK 5.07 GRIND A GENERAL-PURPOSE TURNING TOOL BIT (Con't.)

PERFORMANCE STANDARDS:

- Grind general-purpose turning tool bit for proper end- and side-relief angles and to specifications of instructor.
- Performance process and product must be to standards of the instructor.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Use a pedestal grinder.
- Design and procedures for sharpening tool bit.
- Procedure for "Sharpening a General-Purpose Tool Bit." (See: Krar, S. F., and J. W. Oswald, Turning Technology, Albany, NY: Delmar Publishers Inc., p. 46.)
- Explain how to use a tool bit gage and protractor to check tool bit angles.
- Describe how the lathe bit functions, cuts.
- Describe how to use layout dye and scribe angles to layout a new blank for grinding.
- Expansion of task: Sharpen "V" Threading Tool, Shoulder Threading Tool
- Identify safety considerations.

UNIT 6.0

OPERATING DRILL PRESSES

MACHINE SHOP
OPERATING DRILL PRESSES
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 6.0	OPERATING DRILL PRESSES	
6.01	Inspect, Clean, and Lubricate Drill Press	1
6.02	Set Up a Drill Press	3
6.03	Drill Holes to Size	9 1/2
6.04	Counterbore Hole to Specifications	1
6.05	Countersink Hole to Specifications	2
6.06	Ream Hole to Size	1
6.07	Spotface to Specified Dimensions	1/2
6.08	Mount Work on V-Blocks	1
6.09	Tap Hole with Tapping Attachment	1
	TOTAL HOURS	20

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 6.0	OPERATING DRILL PRESSES
6.01	(Inspect, Clean, and Lubricate Drill Press) Given a drill press, operator's manual or instructions, cleaning materials, lubricants, and the necessary hand tools and materials; inspect, clean, and lubricate the drill press according to manufacturer's recommendations or instructor's standards. The drill press and surrounding area must be free of metal chips, excess lubricant, and foreign material.
6.02	(Set Up a Drill Press) Given a drill press requiring set up for a drilling operation, an assortment of accessories and attachments, vise, parallel bars, V-block yoke and clamps, an assortment of drill bits and collets, and the necessary tools, equipment and materials; set up the drill press for drilling operation. All components must be mechanically secure with the drill bit fastened securely in the collet and the table set up for operation.
6.03	(Drill Holes to Size) Given a drill press, workpiece, detail drawing, drilling specifications, an assortment of drill bits and tools, measuring instruments, and necessary materials; drill holes to specifications with a tolerance of +/- 0.005 inch.
6.04	(Counterbore Hole to Specifications) Using the shop drill press and bits, tools, and necessary materials; counterbore a given workpiece according to drawing/blueprint/specifications provided. The counterbored hole must be to a tolerance of +/- 1/64 inch on decimal dimensions or to specifications.
6.05	(Countersink Hole to Specifications) Provided with a workpiece and drawing/blueprint/specifications, countersink a hole on the workpiece using the shop drill press. The hole must be countersunk to specifications or a tolerance of +/- 1/64 inch on fraction dimensions.
6.06	(Ream Hole to Size) Given a drill press, workpiece, drawing/specifications/blueprint, and the necessary tools, measuring instruments, and materials; ream a hole in the workpiece to drawing specifications to a tolerance of $\begin{array}{l}\underline{+\ 0.0005\text{ inch}}.\\ -\ 0.0000\text{ inch}\end{array}$

6.07 (Spotface to Specified Dimensions) Given the shop drill press, pre-cut workpiece with bored or drilled holes, a boring bar with cutting tool and pilot, detail drawings, spotfacing specifications, and the necessary tools, measuring instruments, and materials; spotface the holes to receive cap screws or nuts. The holes must be spotfaced to specifications with a tolerance of +/- 0.005 inch.

6.08 (Mount Work on V-blocks) Given drill press, round workpiece, drawing and specifications, and necessary accessories, tools, measuring instruments, and materials; mount workpiece for drilling. Mount workpiece so it can be drilled within a tolerance of +/- 1/64 inch.

6.09 (Tap Hole with Tapping Attachment) Given workpiece, shop drill press, working holding devise, tapping attachment, instruction, drills, taps, measuring instruments, combination drill and countersink, and cutting oil; tap a hole in the workpiece with a tapping attachment. The tapped hole should meet blueprint specifications.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.01 INSPECT, CLEAN, AND LUBRICATE DRILL PRESS

PERFORMANCE OBJECTIVE:

Given a drill press, operator's manual or instructions, cleaning materials, lubricants, and the necessary hand tools and materials; inspect, clean, and lubricate the drill press according to manufacturer's recommendations or instructor's standards. The drill press and surrounding area must be free of metal chips, excess lubricant, and foreign material.

PERFORMANCE ACTIONS:

6.0101 Shut off power.

6.0102 Clean drill press:

a. Brush off all chips.
b. Wash grease and oil off machine surfaces.

6.0103 Lubricate drill press according to service manual or given instructions:

a. Coat column and table lightly with oil.
b. Apply grease to fittings.
c. Apply oil to oil cups.
d. Apply oil to sliding parts.

PERFORMANCE STANDARDS:

- Inspect, clean, and lubricate a drill press to given standards.
- The machine and surrounding area must be clean of chips, lubricant, and foreign material.
- The machine must operate properly.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Describe procedures for inspecting and cleaning a drill press.
- Explain the necessary safety precautions.
- Identify materials used to clean a drill press.
- Explain reasons for performing routine inspection and cleaning of a drill press.
- Work holding devices:
    - Parallels
    - C-clamps
    - T-bolts, T-nuts
    - Angle Plates
    - Step Blocks
    - V-blocks
    - Clamps & Straps
- Safety.

DRILL PRESS SAFETY

1. Always wear safety glasses to protect eyes from chips.
2. Always wear tight-fitting clothes to prevent them from becoming caught in revolving parts.
3. Never use the drilling press with guards removed.
4. The chuck key or drill drift should be removed immediately after using so that it will not be thrown from the chuck and injure someone.
5. Remove watches and rings before operating the drill press.
6. Remove chips with a brush, never the hand.
7. Rags should never be used on the drill press while the machine is running, and rags should never be left on the table of a running machine.
8. Work should always be held in a vise or other work holding device, secured to the table and not held with the hands.
9. Ease up when the drill begins to break through the workpiece so that it will not grab and cause a large burr.
10. Drill chucks are used to hold straight shank drills and tools. They are not used with tapered shank tools.
11. The drill drift is the only tool that should be used to remove tapered shank tools from spindles or sleeves.
12. Never clean or make adjustments to a machine in motion.
13. Avoid burns by never picking up a drill, workpiece, or other tools that has just been used and is possibly hot.
14. The drill press table should be kept clean and free of tools to eliminate accidents and possible damage to tools.
15. Spindle tapers should never be cleaned while the spindle is bring turned by power.
16. When drilling deep holes, interrupt the feed occasionally to break up chips and clear the drill.
17. When using chucks and other tools with tapered shanks, always place a board on the table under the tool so that when the taper is broken with the drill drift, it will not fall and damage the tool or table of the drill press.

18. Keep work area clean and free of foreign materials.

19. Clean the drill press and surrounding floor after use.

20. Clean oil or coolant from drills and other tools and return them to proper storage after use.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.02 SET UP A DRILL PRESS

PERFORMANCE OBJECTIVE:

Given a drill press requiring set up for a drilling operation, an assortment of accessories and attachments, vise, parallel bars, V-block yoke and clamps, an assortment of drill bits and collets, and the necessary tools, equipment and materials; set up the drill press for a drilling operation. All components must be mechanically secure with the drill bit fastened securely in the collet and the table set up for operation.

PERFORMANCE ACTIONS:

6.0201 Clean drill press.

6.0202 Select proper drill or accessories.

6.0203 Adjust: table, head, and depth adjustments.

6.0204 If straight-shank drill is used, mount drill in drill chuck. If taper-shank drill is used, insert it directly in spindle, or in a drill sleeve and then in spindle.

6.0205 Turn on power to see if drill is running straight.

6.0206 Mount workpiece in holding device.

6.0207 Follow procedures to drill workpiece (See following task objectives).

PERFORMANCE STANDARDS:

- Set up a drill press for operation using given accessories and material so that the drill press and components are mechanically secure and prepared for the required operation.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Identify: Variable speed control, head, motor, power feed, spindle, table, column, base and quill.
- Identify and explain: Drilling, reaming, boring, counterboring, countersinking, and tapping.
- Explain how to calculate speeds and feeds on a drill press.
- Identify attachments and accessories for the drill press.
- Identify sizes and capacities of various drill presses.
- Identify procedures for setting up a drill press.
- Explain how to mount a drill bit and collet in a drill press.
- Explain how to mount a vise and align a workpiece.
- Work holding devices.
- Work holding procedures.
- Safety.
- Drill chucks and tool holding procedures.

UNIT	6.0	OPERATING DRILL PRESSES
TASK	6.03	DRILL HOLES TO SIZE

PERFORMANCE OBJECTIVE:

Given a drill press, workpiece, detail drawing, drilling specifications, an assortment of drill bits and tools, measuring instruments, and necessary materials; drill holes to specifications with a tolerance of +/- 0.005 inch.

PERFORMANCE ACTIONS:

6.0301 Assemble materials.

6.0302 Set up drill press.

6.0303 Select holding device and accessories.

6.0304 Secure work-hoiding device.

6.0305 Determine hold size.

6.0306 Align workpiece with center drill in chuck.

6.0307 Calculate speed.

6.0308 Set drill press speed.

6.0309 Center drill speed.

6.0310 Select and mount drill bit.

6.0311 Reset speed.

6.0312 Drill to specifications:

  a. Use required lubricant.
  b. Slow feed as drill penetrates workpiece.
  c. Deburr hole.

6.0313 Measure drilled hole(s).

PERFORMANCE STANDARDS:

- Drill hole or holes to size in given workpiece with a tolerance of +/- 0.005 or to specifications.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.03 DRILL HOLES TO SIZE (Con't.)

SUGGESTED INSTRUCTION TIME: 9 1/2 Hours

RELATED TECHNICAL INFORMATION:

- Technique of easing up pressure as drill print breaks through work.
- Drilling techniques with thin metal.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.04 COUNTERBORE HOLE TO SPECIFICATIONS

PERFORMANCE OBJECTIVE:

Using the shop drill press and bits, tools, and necessary materials; counterbore a given workpiece according to drawing/blueprint/ specifications provided. The counterbored hole must be to a to a tolerance of +/- 1/64 inch on decimal dimensions or to specifications.

PERFORMANCE ACTIONS:

6.0401 Assemble materials.

6.0402 Set up drill press.

6.0403 Center punch hole location.

6.0404 Secure workpiece in work-holding device.

6.0405 Locate and clamp workpiece to table.

6.0406 Center drill workpiece.

6.0407 Drill workpiece.

6.0408 Select counterbore and secure in drill press.

6.0409 Counterbore to specifications:

- a. Apply required cutting oil.
- b. Set speed.
- c. Set drill press stop.
- d. Hold cutter in place to complete full cut.

6.0410 Verify measurements of counterbore with tolerances.

PERFORMANCE STANDARDS:

- Counterbore hole to specifications, +/- 1/64 inch on fraction dimensions, using drill press, support tools and materials, and stock provided.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- How to set up drill press.
- Layout of workpiece.
- Operation of drill press.
- Explain why and when to use cutting oil.
- Precision measuring.
- Define counterboring.
- Describe how to calculate cutting speed and feed.
- Safety.

UNIT	6.0	OPERATING DRILL PRESSES
TASK	6.05	COUNTERSINK HOLE TO SPECIFICATIONS

PERFORMANCE OBJECTIVE:

Provided with a workpiece and drawing/blueprint/specifications, countersink a hole on the workpiece using the shop drill press. The hole must be countersunk to specifications or a tolerance of +/- 1/64 inch on fraction dimensions.

PERFORMANCE ACTIONS:

6.0501 Assemble materials.

6.0502 Set up drill press.

6.0503 Center punch hole location.

6.0504 Secure workpiece in work-holding device.

6.0505 Center work under center drill and clamp.

6.0506 Center drill workpiece.

6.0507 Select drill and secure it in drill chuck.

6.0508 Drill hole in workpiece.

6.0509 Select countersink and secure in drill press.

6.0510 Align countersink to hole.

6.0511 Countersink to specifications:

a. Apply cutting oil.
b. Set stop.
c. Set speed.
d. Hold cutter in place at end of cut to obtain full depth of cut.

6.0512 Verify dimensions.

PERFORMANCE STANDARDS:

- Countersink hole to specifications or +/- 1/64 inch fraction using drill press and materials and tools supplied.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT	6.0	OPERATING DRILL PRESS
TASK	6.05	COUNTERSINK HOLE TO SPECIFICATIONS (Con't.)

RELATED TECHNICAL INFORMATION:

- Set up drill press.
- Layout workpiece.
- Operation of drill press.
- Use of cutting oil.
- Precision measuring.
- Define countersinking.
- Describe how to calculate cutting speed and feed.
- Explain use of cutting fluid.
- Explain why a standard machine shop countersink is ground to a certain angle.
- Safety.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.06 REAM HOLE TO SIZE

PERFORMANCE OBJECTIVE:

Given a drill press, workpiece, drawing/specifications/blueprint, and the necessary tools, measuring instruments, and materials; ream a hole in the workpiece to drawing specifications to a tolerance of
+0.0005 inch.
-0.0000 inch

PERFORMANCE ACTIONS:

6.0601 Assemble materials.

6.0602 Set up drill press, drill speed.

6.0603 Secure holding device and accessories.

6.0604 Secure work in holding device.

6.0605 Align workpiece and center drill and clamp holding device.

6.0606 Center drill workpiece (lubricate as needed).

6.0607 Select drill and drill workpiece to dimensions, lubricating as necessary:

  a. Drill undersize for reaming allowance.

6.0608 Select reamer.

6.0609 Change drill press speed to one-half drilling speed.

6.0610 Ream hole:

  a. Mount reamer in chuck.
  b. Lubricate as required.
  c. Feed through workpiece.
  d. Clean and deburr.

6.0611 Measure hole.

PERFORMANCE STANDARDS:

- In given workpiece, ream hole to size using shop drill press and to specifications, +0.0005 inch.
  -0.0000 inch

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.06 REAM HOLE TO SIZE (Con't.)

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Identify sizes, types, nomenclature, specifications, selection, and storage of machine reamers.
- Safety.
- Reamer care.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.07 SPOTFACE TO SPECIFIED DIMENSIONS

PERFORMANCE OBJECTIVE:

Given the shop drill press, pre-cut workpiece with bored or drilled holes, a boring bar with cutting tool and pilot, detail drawings, spotfacing specifications, and the necessary tools, measuring instruments, and materials; spotface the holes to receive cap screws or nuts. The holes must be spotfaced to specifications with a tolerance of +/- 0.005 inch.

PERFORMANCE ACTIONS:

6.0701 Assemble materials.

6.0702 Set up drill press.

6.0703 Select holding device and accessories.

6.0704 Secure work in holding device.

6.0705 Select spotface tool and pilot.

6.0706 Mount spotfacing tool in drill press.

6.0707 Set speed of drill (Machinery's Handbook or instructor's specifications).

6.0708 Set stop for depth.

6.0709 Align workpiece.

6.0710 Start drill press.

6.0711 Spotface workpiece:

a. Lubricant.
b. Face to dimensions.

6.0712 Measure spotface.

6.0713 Re-adjust depth stop and recut spotface as required to meet specifications.

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.07 SPOTFACE TO SPECIFIED DIMENSIONS (Con't.)

PERFORMANCE STANDARDS:

- Spotface a given workpiece to specifications, +/- 0.005 inch, so that the top of the hole produced a bearing surface against which a washer or nut or the head of a cap screw may be brought flat.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Explain purpose of spotfacing.
- Explain why boring bar is used as a pilot.
- Demonstrating mounting cutting tool in boring bar.
- Demonstrate set up for spotfacing.
- Calculate cutting feed and speed.
- Explain use of cutting fluid.
- Describe procedure for spotfacing a hole.
- Safety.

UNIT 6.0 OPERATING DRILL PRESSES
TASK 6.08 MOUNT WORK ON V-BLOCKS

PERFORMANCE OBJECTIVE:

Given drill press, round workpiece, drawing and specifications, and necessary accessories, tools, measuring instruments, and materials; mount workpiece for drilling. Mount workpiece so it can be drilled within a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

6.0801 Clean and deburr workpiece.

6.0802 Clean and deburr V-blocks.

6.0803 Coat workpiece with layout dye at hole location.

6.0804 Measure hole location with square and center punch workpiece.

6.0805 Mount workpiece in V-blocks.

6.0806 Place assembly on surface plate.

6.0807 Locate center punch mark centered on top:

a. Check form each side with square.
b. Check from each side with surface gage.

6.0808 Clamp workpiece in V-blocks.

6.0809 Check accuracy of set up.

6.0810 Mount assembly on drill press table.

6.0811 Place center drill in chuck.

6.0812 Locate center punch mark on workpiece under point of center drill.

6.0813 Clamp assembly to table.

6.0814 Turn on drill press and lightly touch workpiece with center drill to verify set up.

PERFORMANCE STANDARDS:

- Mount workpiece on V-blocks so it can be drilled within a tolerance of +/- 1/64 inch.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 6.0 OPERATING DRILL PRESSES

TASK 6.09 TAP HOLE WITH TAPPING ATTACHMENT

PERFORMANCE OBJECTIVE:

Given workpiece, shop drill press, work holding device, tapping attachment, instruction, drills, taps, measuring instruments, combination drill and countersink, and cutting oil; tap a hole in the workpiece with a tapping attachment. The tapped hole should meet blueprint specifications.

PERFORMANCE ACTIONS:

6.0901 Mount workpiece in work holding device.

6.0902 Select tap drill and tap.

6.0903 Mount center drill in drill press.

6.0904 Secure workpiece to drill press table aligned with center drill.

6.0905 Set speed and feed.

6.0906 Center drill, then drill hole.

6.0907 Mount and secure tapping attachment.

6.0908 Tap hole to specifications:

a. Mount tap in collet.
b. Follow manufacturer's/instructor's procedures for tapping attachment operation.
c. Set drill press speed.
d. Set drill press stop when required.
e. Allow tap to complete cut to full depth before retracting from hole.

6.0909 Clean tapped hole and check with gage.

PERFORMANCE STANDARDS:

- Tape hole with tapping attachment so hole and workpiece meet specifications and instructor's standards.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 7.0

POWER SAWS

For the purpose of this guide, power saws will include:

- Vertical Bandsaw (Contour Saw)
- Horizontal Bandsaw
- Power Hacksaw, available at 1 career center

MACHINE SHOP
POWER SAWS
SUGGESTED INSTRUCTION TIMES

POWER SAWS UNIT/TASK		SUGGESTED HOURS
Unit 7.0	POWER SAWS	
7.01	Clean and Lubricate Power Saws	1/4
7.02	Cut and Weld Bandsaw Blade	3
7.03	Replace Bandsaw Blade	3/4
7.04	Saw Internal Contours with Bandsaw	3
7.05	Saw to Scribed Line	3
7.06	Select and Set Speeds and Feeds for Sawing Operations	1/4
7.07	Make Straight and Angular Cuts with Power Saw	3
7.08	Cut Material to Length with Power Hacksaw or Horizontal Bandsaw	6 3/4
	TOTAL HOURS	18

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 7.0	POWER SAWS
7.01	(Clean and Lubricate Power Saws) Provided with a power saw and instructions and cleaner, lubricant, rags, brush, feeler gage, wrenches, blade guide inserts, necessary materials; clean and lubricate the power saw according to manufacturer's specifications and make required adjustments.* *For the band saw, adjust band guide allowing clearance of 0.00001 inch - 0.002 inch. The power saw and surrounding area must be free of metal chips, excess lubricant, cutting fluid, and foreign material.
7.02	(Cut and Weld Bandsaw Blade) Following instructions and manufacturer's recommendations/specifications, cut and weld a given bandsaw blade so that it is straight, annealed, and without flash.
7.03	(Replace Bandsaw Blade) Furnished with bandsaw and replacement blade, hand tools, and necessary instruction and references; replace the bandsaw blade so that the new blade is aligned and adjusted to manufacturer's specifications.
7.04	(Saw Internal Contours with Bandsaw) Given workpiece, blueprint/drawing, references, and the bandsaw; saw internal contours of the workpiece so that the internal cut on the workpiece is within +/- 1/32 inch of scribed line to a tolerance of +/- 1/64 inch.
7.05	(Saw to Scribed Line) Following given sketch or blueprint and using a work-holding device, provided bandsaw, and measuring instruments and other tools/materials as required; saw the workpiece to scribed lines and job specifications within +/- 1/32 inch of scribed lines.
7.06	(Select and Set Speeds and Feeds for Sawing Operations) Furnished with drawing or blueprint/specifications, workpiece, and power saw; set speed and feed for sawing operation specified. Speed and feed should be set according to recommendations in Machinery's Handbook or information provided by the instructor.

7.07 (Make Straight and Angular Cuts with Power Saw) Given the horizontal bandsaw or a power hacksaw, specifications, necessary tools and materials, and a workpiece or stocks; cut given metal to the specified dimensions, +/- 1/32 inch.

7.08 (Cut Materials to Length with Power Hacksaw or Horizontal Bandsaw) Provided with a power hacksaw, or horizontal bandsaw, instructions concerning operation of the power saw, measuring tools, workpiece; cut workpiece to specified length within a tolerance of +/- 1/32 inch.

UNIT 7.0 POWER SAWS

TASK 7.01 CLEAN AND LUBRICATE POWER SAWS

PERFORMANCE OBJECTIVE:

Provided with a power saw and instructions and cleaner, lubricant, rags, brush, feeler gage, wrenches, blade guide inserts, necessary materials; clean and lubricate the power saw according to manufacturer's specifications and make required adjustment.*

*For the bandsaw, adjust band guide allowing clearance of 0.0001 inch - 0.002 inch.

The power saw and surrounding area must be free of metal chips, excess lubricant, cuting fluid, and foreign material.

PERFORMANCE ACTIONS: (Omit actions not applicable.)

7.0101 Take safety precautions.

7.0102 Clean off all chips with brush.

7.0103 Clean oil and dirt from saw.

7.0104 Lubricate saw to manufacturer's specifications:

- a. Grease fittings.
- b. Oil in oil cups.
- c. Oil slides lightly.

7.0105 Inspect saw:

- a. Check tension on blade.
- b. Check vertical alignment of blade.
- c. Check blade for sharpness and damage.
- d. Mount inserts and adjust to tolerance with feeler gage.

7.0106 Verify adjustments with short test run.

PERFORMANCE STANDARDS:

- Clean and lubricate given power saw(s) according to manufacturer's instructions so that the saw and surrounding area is clean and the saw is properly lubricated and adjusted and operates properly.

SUGGESTED INSTRUCTION TIME: 1/4 Hour

UNIT 7.0 POWER SAWS

TASK 7.01 CLEAN AND LUBRICATE POWER SAWS (Con't.)

RELATED TECHNICAL INFORMATION:

- Identify power cut-off saws by type, sizes, nomenclature, and range of work.
- Identify safe practices and work habits on the power saw (belt and pully guards, loose clothing, jewelry, hair, cutting short pieces, cutting in an old cut with new blade, personal safety).
- Care of power saws.

UNIT 7.0 POWER SAW

TASK 7.02 CUT AND WELD BANDSAW BLADE

PERFORMANCE OBJECTIVE:

Following instructions and manufacturer's recommendations/specifications, cut and weld a given bandsaw blade so that it is straight, annealed, and without flash.

*If welding equipment is not available, this will be an orientation task.

PERFORMANCE ACTIONS:

7.0201 Cut off electrical power to saw.

7.0202 Remove blade tension.

7.0203 Cut blade (or remove broken blade).

7.0204 Grind blade ends square.

7.0205 Clean welder jaws and inserts.

7.0206 Insert blade in welder jaws:

  a. Point saw teeth in.
  b. Butt ends.
  c. Center in gap (.040 inch).
  d. Clamp.

7.0207 Set pressure, wear goggles, and weld using proper procedures for individual machine.

7.0208 Loosen clamps, set for annealing, clamp for annealing.

7.0209 Anneal blade until it reaches a dull cherry red color:

  a. Jog button, allowing temperature to drop off slowly (5-10 seconds).
  b. (NOTE: Typically this will be orientation training since skill development may require a few practice welds.)

7.0210 Remove blade from welder.

UNIT 7.0 POWER SAW

TASK 7.02 CUT AND WELD BANDSAW BLADE

PERFORMANCE ACTIONS (Con't.):

7.0211 a. Grind off bead or flash from weld being careful not to:
- Undercut the weld or,
- Damage the saw teeth.

b. Anneal blade second time to "straw" color, allowing blade to cool slowly.

7.0212 Pass welded area through band thickness gage as a check.

7.0213 Remount blade and adjust proper tension, ensuring that blade teeth are in proper direction.

7.0214 Test run blade.

PERFORMANCE STANDARDS:

- Cut and weld a bandsaw blade so that it is straight, annealed, and without flash and mount it on the saw for proper operation.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Safety.
- Preparing a blade for welding.
- Welding.
- Annealing.
- Removing, install, and adjusting a blade.

UNIT 7.0 POWER SAW

TASK 7.03 REPLACE BANDSAW BLADE

PERFORMANCE OBJECTIVE:

Furnished with bandsaw and replacement blade, hand tools, and necessary instruction and references; replace the bandsaw blade so that the new blade is aligned and adjusted to manufacturer's specifications.

PERFORMANCE ACTIONS:

7.0301 Select saw blade (assemble materials).

7.0302 Release tension on blade.

7.0303 Remove blade.

7.0304 Loop blade for storage.

7.0305 Check guides and remove and install new guides according to operator's manual, etc.

7.0306 Unwind new blade.

7.0307 Install new blade.

7.0308 Apply proper tension to blade according to recommendations.

7.0309 Inspect blade direction and guide seating.

7.0310 Test operation.

PERFORMANCE STANDARDS:

- Replace bandsaw blade so that the new blade is aligned and adjusted to manufacturer's specifications.

SUGGESTED INSTRUCTION TIME: 3/4 Hour

RELATED TECHNICAL INFORMATION:

- Safety.
- Selecting a saw blade for an assigned job.

UNIT 7.0 POWER SAWS

TASK 7.04 (Orientation) SAW INTERNAL CONTOURS WITH BANDSAW

PERFORMANCE OBJECTIVE:

Given workpiece, blueprint/drawing, references, and the bandsaw; saw internal contours of the workpiece so that the internal cut on the workpiece is within +/- 1/32 inch of scribed line to a tolerance of +/- 1/64 inch.

(NOTE: Unless indicated otherwise, this skill is for orientation.)

PERFORMANCE ACTIONS:

7.0401 Check workpiece for sharp internal curves.

7.0402 Check minimum radius limit of blade.

7.0403 Center punch hole for inserting blade:

a. Hole must be larger than blade width.
b. Mark holes for sharp curves.

7.0404 Drill hole(s) in workpiece.

7.0405 Remove blade from bandsaw.

7.0406 Cut bandsaw blade (near original weld).

7.0407 Insert blade through drilled hole in workpiece.

7.0408 Weld bandsaw blade:

a. Grind ends square.
b. Weld.
c. Anneal.
d. Grind off flash. .
e. Anneal second time to "straw" color.

7.0409 Mount blade on bandsaw and adjust tension:

a. Point teeth down.
b. Check vertical alignment.

7.0410 Saw workpiece internally:

a. Stay +/- 1/32 inch from layout lines.
b. Check radius of cuts for arcs or curves.

UNIT 7.0 POWER SAWS

TASK 7.04 (Orientation) SAW INTERNAL CONTOURS WITH BANDSAW

PERFORMANCE ACTIONS (Con't.):

7.0411 Turn off bandsaw and remove blade and workpiece.

7.0412 Cut blade (cut off original weld).

7.0413 Remove blade from workpiece and reweld blade.

7.0414 Replace blade on bandsaw and adjust tension and alignment.

PERFORMANCE STANDARDS:

- Saw internal contours with bandsaw so that the internal cut is within +/- 1/32 inch of scribed line to a tolerance of +/- 1/64 inch.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Drilling corner holes (cutting square corner without drilling a hole).
- Notching the corner square.
- Producing a square corner by turning the work.
- Cutting blade to remove old weld, if applicable.
- Safety.

UNIT 7.0 POWER SAW

TASK 7.05 SAW TO SCRIBED LINE

PERFORMANCE OBJECTIVE:

Following given sketch or blueprint and using a work-holding device, provided bandsaw, and measuring instruments and other tools/materials as required; saw the workpiece to scribed lines and job specifications within +/- 1/32 inch of scribed lines.

PERFORMANCE ACTIONS:

7.0501 Ensure that scribed lines are properly located and clear.

7.0502 Mount and align machine guide, as necessary.

7.0503 Ensure that correct blade is mounted on saw.

7.0504 Determine and set cutting speed.

7.0505 Adjust and clamp saw guide.

7.0506 Secure work in work-holding device, as required.

7.0507 Saw workpiece:

a. Support workpiece, as required.
b. Align scribed line to blade.
c. Advance workpiece into saw with steady pressure.
d. Saw to specifications (1/32 inch from line on waste side).
e. Note any sharp curves.

PERFORMANCE STANDARDS:

- Saw workpiece with bandsaw to required specifications +/- 1/32 inch of scribed lines.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Safety.

UNIT 7.0 POWER SAW

TASK 7.06 SELECT AND SET SPEEDS AND FEEDS FOR SAWING OPERATIONS

PERFORMANCE OBJECTIVE:

Furnished with drawing or blueprint/specifications, workpiece, and power saw; set speed and feed for sawing operation specified. Speed and feed should be set according to recommendations in Machinery's Handbook or information provided by the instructor.

PERFORMANCE ACTIONS:

7.0601 Review print/drawing/specification.

7.0602 Determine material to be sawed.

7.0603 Determine type of saw to be used.

7.0604 Determine type of blade.

7.0605 Determine machine speed:

a. Check speed chart on machine, if available.
b. Check reference for cutting speed.
c. Calculate speed, if required.

7.0606 Set machine speed according to manufacturer's recommendations.

7.0607 Determine feed requirement and set feed according to manufacturer's recommendations.

PERFORMANCE STANDARDS:

- Select and set speeds and feeds for sawing operations according to recommendations in Machinery's Handbook or information provided by the instructor.

SUGGESTED INSTRUCTION TIME: 1/4 Hour

RELATED TECHNICAL INFORMATION:

- Safety.
- Machinery's Handbook.

UNIT 7.0 POWER SAW

TASK 7.07 MAKE STRAIGHT AND ANGULAR CUTS WITH POWER SAW

PERFORMANCE OBJECTIVE:

Given the horizontal bandsaw or a power hacksaw, specifications, necessary tools and materials, and a workpiece or stocks; cut given metal to the specified dimensions, +/- 1/32 inch.

PERFORMANCE ACTIONS:

7.0701 Assemble material to cut.

7.0702 Measure material and scribe/mark lines.

7.0703 Set up power saw.

7.0704 Make required cuts to specifications:

a. Straight.
b. Angular, as required.

7.0705 Check dimensions.

PERFORMANCE STANDARDS:

- Make straight and angular cuts with power saw to specifications.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Sawing angle or channel stock.
- Sawing pipe or tube.
- Selection of blades.
- Leaving extra length when cutting off material.

UNIT	7.0	POWER SAW
TASK	7.08	CUT MATERIAL TO LENGTH WITH POWER HACKSAW OR HORIZONTAL BANDSAW

PERFORMANCE OBJECTIVE:

Provided with a power hacksaw or horizontal bandsaw, instructions concerning operation of the power saw, measuring tools, workpiece; cut workpiece to specified length within a tolerance of +/- 1/32 inch.

PERFORMANCE ACTIONS:

7.0801 Review job specifications for dimensions.

7.0802 Measure to dimensions.

7.0803 Scribe or mark measurements.

7.0804 Select saw blade according to references provided, if applicable.

7.0805 Mount blade, if applicable.

7.0806 Check vise with square, if applicable.

7.0807 Set saw speed, if applicable.

7.0808 Set saw feed.

7.0809 Clamp workpiece in vise (as applicable):

a. Align blade on waste side of cut.
b. Support long pieces with floor stand.

7.0810 Start saw.

7.0811 Lower blade to workpiece and engage feed.

7.0812 Deburr workpiece and check measurements.

PERFORMANCE STANDARDS:

- Cut material to specified lengths with the power hacksaw or horizontal bandsaw with an accuracy of +/- 1/32 inch of specifications.
- Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 6 3/4 Hours

RELATED TECHNICAL INFORMATION: (Expanded objectives)

- Set up a power hacksaw or horizontal bandsaw for a cutting operation so that all components are mechanically secure.
- Identify and select hacksaw blades (as applicable).
- Install a power hacksaw blade with the teeth facing the direction of cut, the blade mounted securely to the blade holder or arm with socket head screws and tensioned to specifications with hardened bolts (as applicable).
- Identify and use work-holding devices on the power saw, demonstrating proper positioning of the workpiece.
- Saw straight cuts with the power saw to specifications within +/- 1/32 inch, - .000 inch.
- Saw angular cuts with the power saw to a tolerance of +/- 1 degree for squareness and +/- 1/32 inch, - .000 inch for dimensions.
- Identify safety considerations.

UNIT 8.0

BASIC ENGINE LATHE WORK

This Basic Engine Lathe Work unit is designed to provide the secondary student with an introduction to the Engine Lathe and the fundamental skills necessary to operate the Engine Lathe.

During the second year of secondary level training, the student's knowledge and skills in lathe work will be expanded at a more difficult level and will include an introduction to the Turret Lathe.

Although lathe work is described as basic and advanced lathe work and although the tasks are distributed over two years of instruction, the tasks may be combined for more effective and efficient instruction as appropriate.

MACHINE SHOP
BASIC ENGINE LATHE WORK
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 8.0	BASIC ENGINE LATHE WORK	
8.01	Inspect and Clean an Engine Lathe	9
8.02	Set Up Engine Lathe for Turning Operations	9
8.03	Align Lathe Centers Using Accurate Measurement Techniques	2
8.04	Mount Workpiece Between Centers	12
8.05	Align Workpiece on Faceplate	1
8.06	Align Workpiece in Four-Jaw Chuck	4
8.07	Make Roughing Cuts	24
8.08	Make Finishing Cuts	20
8.09	Turn a Workpiece to Dimensions	20
8.10	Face a Workpiece to Dimensions	10
8.11	Knurl a Workpiece	4
8.12	Drill Holes with Lathe	10
8.13	Ream Holes on the Lathe	2
8.14	Bore Holes	2
8.15	Counterbore Holes	2
8.16	Countersink Holes Using the Lathe	1
8.17	Tap Holes	2
8.18	Cut Grooves or Recess	2
8.19	Machine an External Chamfer	2
8.20	Machine an Internal Chamfer	2
8.21	Part Workpieces	4

8.22	File Workpieces	6
8.23	Polish Workpieces	5
	TOTAL HOURS (FIRST YEAR)	155

ADVANCED ENGINE LATHE WORK
(SECOND YEAR)

8.24	Grind Workpiece with Tool Post Grinder	2
8.25	Machine External Taper	9
8.26	Machine Internal Taper	3
8.27	Machine External Angle	2
8.28	Machine Internal Angle	1
8.29	Set Up Lathe for Threading Operations	12
	TOTAL HOURS (SECOND YEAR)	29

TOTAL OF ENGINE LATHE INSTRUCTIONAL HOURS: 184

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 8.0	BASIC ENGINE LATHE WORK
8.01	(Inspect and Clean an Engine Lathe) Given an engine lathe, operator's manual or instructions, cleaning materials, and the necessary hand tools and equipment; inspect and clean the engine lathe in accordance with manufacturer's specifications. The lathe and surrounding area must be free of metal chips, excess lubricant, cutting fluid, and foreign material.
8.02	(Set Up Engine Lathe for Turning Operations) Given an engine lathe requiring set up for turning operations, a faceplate and dogs, a three- or four-jaw universal chuck, pre-cut cylindrical stock, toolholder and bit, and the necessary tools, equipment, and materials; set up the engine lathe for turning operations requiring a faceplate and chuck. All components must be mechanically secure. The tool bit must be secured in the holder and set at the point of dead center on the stock. The faceplate and dog must be mounted so that the tailstock engages the stock in the center. The chuck must be mounted securely to the threaded spindle with the jaws tightened to hold the workpiece. Spindle threads must be damaged and must be clean and free of chips or lint.
8.03	(Align Lathe Centers Using Accurate Measurement Techniques) Provided with a lathe and measuring instruments, align the lathe centers. Centers must be aligned with tolerance of +/- 0.0005 inch.
8.04	(Mount Workpiece Between Centers) Given an engine lathe, pre-cut cylindrical stock with scribed centers, a faceplate and dog, combination drill and countersink, detail drawings, specifications, and the necessary tools, equipment, and materials; center drill the workpiece and mount it between the centers. The workpiece must be center drilled to specifications with a tolerance of +/- 0.005 inch for location, diameter, and depth. The workpiece must be mounted with the soft center in the live (headstock) center and the hardened center in the deal (tailstock) center to specifications. The tailstock must be fastened securely with room for the saddle and tool block to operate.
8.05	(Align Workpiece on Faceplate) Given a workpiece, lathe, measuring tools, faceplate and all necessary accessories, tools, and materials; align the workpiece on the lathe faceplate with an accuracy of +/- 0.001 inch.

8.06 (Align Workpiece in Four-Jaw Chuck) Furnished with workpiece, lathe, and measuring instruments, align workpiece in the four-jaw chuck with a tolerance of +/- 0.001 inch.

8.07 (Make Roughing Cuts) Given an engine lathe with a mounted workpiece, a dimensioned drawing or blueprint, toolholder and roughing bit, and the necessary tools, measuring instruments, and materials; making roughed cuts of .010 inch per revolution. The workpiece must be roughed to size with 1/32 inch allowed for a finishing cut. When the workpiece is turned to within 1/2 inch of the dog or 1 inch of the chuck jaws, it must be removed and turned to rough dimensions.

8.08 (Make Finishing Cuts) Given an engine lathe with a rough cut workpiece mounted in a chuck or in a faceplate, a detail drawing, toolholder and finishing bit, and the necessary tools, equipment, and materials; make finishing cuts of .003 inch per revolution. The workpiece must be finished to size with a tolerance of +/- .003 inch.

8.09 (Turn a Workpiece to Dimensions) Given an engine lathe, cylindrical stock, a detail drawing that requires various diameters, toolholder and bits, and the necessary tools, measuring instruments, and materials; turn the workpiece to dimensions. The diameters and dimensions must meet specifications with a tolerance of +/- 0.005 inch.

8.10 (Face a Workpiece to Dimensions) Given cylindrical stock, a detail drawing that required several facing operations, toolholder and bits, and the necessary tools, measuring instructions, and materials; face the workpiece to dimensions using the engine lathe so that the workpiece meets specifications with a tolerance of +/- 0.005 inch.

8.11 (Knurl a Workpiece) Given an engine lathe, cylindrical stock, a detail drawing of a knurled part, knurling specifications, diamond and straight knurling tools, and the necessary tools, measuring instruments, and materials; knurl the workpiece to specifications using course, medium, and fine rollers as required. The knurl must meet specifications with a tolerance of +/- 1/64 inch.

8.12 (Drill Holes with Lathe) Given an engine lathe, cylindrical parts, a detail drawing of parts to be drilled, drilling specifications, a drill chuck and drill bits, and the necessary tools, measuring instruments, and materials; drill holes in the parts using the lathe tailstock. The holes must be drilled to specifications with a tolerance of +/- .003 inch for location, $\begin{array}{l}\underline{+ .002\text{ inch}}\\ - .000\text{ inch}\end{array}$ for diameter, and +/- 1/64 inch for depth.

8.13 (Ream Holes on the Lathe) Given an engine lathe, cylindrical parts, a detailed drawing of drilled holes to be reamed, reaming specifications, a drill chuck and reaming tools, and the necessary tools, measuring instruments, and materials; ream the drilled holes using the lathe tailstock. The holes must be reamed to specifications with a tolerance of
+ 0.005 inch.
- 0.000 inch

8.14 (Bore Holes) Given an engine lathe, pre-cut cylindrical stock with undersized-drilled holes, an assortment of boring tools, a detail drawing, boring specifications, and the necessary tools, measuring instruments, and materials; bore holes using a steady rest attachment. The holes must be bored to specifications with a tolerance of +/- .001 inch for location, diameter, and depth, and +/- 1 degree for perpendicularity.

8.15 (Counterbore Holes) Given an engine lathe, pre-cut cylindrical stock with bored holes, an assortment of counterboring tools, a detail drawing, counterboring specifications, and the necessary tools, attachments, measuring instruments, and the materials; counterbore the holes. The holes must be counterbored to specifications with a tolerance of +/- 0.001 inch.

8.16 (Countersink Holes Using the Lathe) Provided with an engine lathe, measuring instruments, and assortment of countersinking tools, detail drawings, countersinking specifications, and the necessary tools, attachments, and materials as well as pre-cut cylindrical stock with bored holes; countersink the holes. The holes must be countersunk to specifications.

8.17 (Tap Holes) Given an engine lathe, pre-cut cylindrical or rectangular stock with drilled holes, detail drawings, tapping specifications, machine taps, and the necessary tools, attachments, measuring instruments, and materials; tap required holes in the stock. The tapped holes must be threaded to specifications.

8.18 (Cut Grooves or Recess) Given an engine lathe, cylindrical stock, a detail drawing that required several recesses or grooves (v-shaped, square, and round). groove or neck specifications, toolholder and tool bits, and the necessary tools, measuring instruments, and materials; turn the grooves or necks specified for the stock with a tolerance of +/- .005 inch.

8.19 (Machine an External Chamfer) Provided with an engine lathe, cylindrical stock, a detail drawing that required an external chamfer, toolholder and bits, and the necessary tools, measuring instruments, and materials; machine an external chamfer on the stock. The chamfer must be machined to specifications with a tolerances of +/- .005 inch.

8.20 (Machine an Internal Chamfer) Provided with an engine lathe, cylindrical stock, a detail drawing that required an internal chamfer, toolholder and bits, and the necessary tools, measuring instruments, and materials; machine an internal chamfer in the stock. The chamfer must be machined to specifications with +/- .005 inch.

8.21 (Part Workpieces) Provided with an engine lathe, cylindrical workpieces requiring parting, detail drawings, parting specifications, toolholder and parting tools, and the necessary tools, measuring instruments, and materials; part the workpieces to specifications with a tolerance of +/- 1/64 inch.

8.22 (File Workpieces) Provided with an engine lathe, cylindrical workpieces requiring filing, detail drawings, surface finish specifications in micro-inches, as assortment of files, and the necessary tools, measuring instruments, and materials; file the workpieces to specifications for surface finish.

8.23 (Polish Workpieces) Given an engine lathe, cylindrical workpieces that have been filed, detail drawings, surface finish specifications in micro-inches, and assortment of abrasives, and the necessary tools, measuring instruments, and materials; polish workpieces to specifications for surface finish.

8.24 (Grind Workpiece with Tool Post Grinder) Provided with blueprint, workpiece, lathe and accessories including tool post grinder; grind workpiece with tool post grinder. Work must meet blueprint specifications with a tolerance of +/- 0.0005 inches.

8.25 (Machine External Taper) Provided with the engine lathe, workpiece, detail drawing requiring external taper, tapering attachment, taper specifications, toolholder and tool bits, and necessary hand tools, measuring instruments, and materials; machine external taper using tailstock setover method of the tapering attachment. The taper must be machined to specifications with a tolerance of .001 inches per 4 inches.

8.26 (Machine Internal Taper) Using the engine lathe and provided workpiece, detail drawing requiring internal taper, tapering attachment, taper specifications, toolholder and tool bits, and the necessary hand tools, measuring instruments, and materials; machine internal taper with tapering attachment meeting specifications with a tolerance of .001 inch per 4 inches.

8.27 (Machine External Angle) Given the engine lathe, a workpiece set up for machining an external angle, a detail drawing, angle specifications, toolholder and tool bits, and the necessary hand tools, measuring instruments, and materials; machine the external angle using the compound rest method. The angle must be machined to specifications with a tolerance of +/- 30 minutes for the angle and +/- .001 inch for the diameters.

8.28 (Machine Internal Angle) Provided with the engine lathe, workpiece set up for machining an internal angle, detail drawing, angle specifications, toolholder and tool bits, and necessary hand tools, measuring instruments, and materials; machine internal angle using compound rest method to specifications with tolerance of +/- 30 minutes for angle and +/- 0.10 inch for diameter.

8.29 (Set Up Lathe for Threading Operations) Given the requirement for various threading operations on the engine lathe, a faceplate and dogs, a universal or independent chuck, pre-cut cylindercial stock, toolholder, and single point tool bits, and the necessary hand tools, measuring instruments, and materials; set up the engine lathe for threading operations. All components must be mechanically secure. The tool bit must be secured in the toolholder and set square with the workpiece. The thread chasing dial must be positioned for specified threading operations including even, odd, and fractional divisions. The end of each workpiece must be chamfered with the side of the threading tool to .005 inch below minor diameter of the thread.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.01 INSPECT AND CLEAN AN ENGINE LATHE

PERFORMANCE OBJECTIVE:

Given an engine lathe, operator's manual or instructions, cleaning materials, and the necessary hand tools and equipment; inspect and clean the engine lathe in accordance with manufacturer's specifications. The lathe and surrounding area must be free of metal chips, excess lubricant, cutting fluid, and foreign material.

PERFORMANCE ACTIONS:

INSPECT THE LATHE:

8.0101 Given a diagram of a lathe, identify each part or control and describe its use accurately and list at least five operations which can be performed on a lathe:

a. Identify engine lathe types and sizes.
b. Identify and describe the purpose of the parts of a lathe on a diagram provided by the instructor.
    (1) Purpose of headstock
    (2) Standard verses quick change geared
    (3) "Live center" verses "dead center"
c. List operations which can be performed on a lathe.

8.0102 Given a selection of lathe work holding devices, identify each type of chuck and describe its relative accuracy to the instructor's standards:

a. Identify several types of chucks in the shop.
b. Drive plates, face plates, collets.
c. Carriage accessories: Follower rest, toolpost.
d. Lathe bed accessories: Taper attachment, steady rest, etc.

CLEAN THE LATHE:

8.0103 Be sure electrical switch is off.

8.0104 Do not use compressed air.

8.0105 Do not remove steel chips by hand brushing, etc., because of possible injury.

8.0106 Use a paint brush to remove dirt and chips.

PERFORMANCE ACTIONS (Con't.):

8.0107 Remove traces of dirt and sluge with a clean cloth, possibly with a light coat of oil on the cloth to protect against rust.

8.0108 On a regular schedule, established by the instructor, clean the lathe with kerosene or varsol or similar cleaner provided by the instructor to remove gum and oil stains.

PERFORMANCE STANDARDS:

- Inspect, identify the parts, and clean an engine lathe according to manufacturer's specifications and instructor's standards so that the lathe and surrounding area are free from metal chips, excess lubricant, cutting fluid, and foreign material.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Explain reasons for performing routine inspection and cleaning of engine lathe.
- Describe procedures for inspecting and cleaning engine lathe.
- Describe typical materials used to clean a lathe.
- Safety.
- Diagram a lathe.
- Types of chucks.

EXPANSION OF OBJECTIVE:

Inspect engine lathe components for wear and accuracy and make necessary adjustments according to the operator's manual (manufacturer's or instructor's recommendations).

1. Check wear of bearing surfaces on sides or cross-slide, compound rest, taper attachment, or carriage:
    a. Adjust flat or tapered gibs to compensate for wear between mating parts.
    b. Sliding surfaces are cleaned and lubricated and so that no play exists between the sliding parts and a slight drag should be felt when the feed screws or controls are operated.

EXPANSION OF OBJECTIVE (Con't.):

2. Check shear pins and clutches: (As safety devices)
    a. Exercise caution in removing or replacing shear pins.
    b. Never replace a brass shear pin with a steel pin. Replace shear pins with the proper type, size, and shape.
    c. Adjust slip clutches according to manufacturer's standards.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.02 SET UP ENGINE LATHE FOR TURNING OPERATIONS

PERFORMANCE OBJECTIVE:

Given an engine lathe requiring set up for turning operations, a faceplate and dogs, a three- or four-jaw universal chuck, pre-cut cylindrical stock, toolholder and bit, and the necessary tools, equipment, and materials; set up the engine lathe for turning operations requiring a faceplate and chuck. All components must be mechanically secure. The tool bit must be secured in the holder and set at the point of dead center on the stock. The faceplate and dog must be mounted so that the tailstock engages the stock in the center. The chuck must be mounted securely to the threaded spindle with the jaws tightened to hold the workpiece. Spindle threads must not be damaged and must be clean and free of chips or lint.

PERFORMANCE ACTIONS:

8.0201 Assemble engine lathe accessories, tool, and materials.

8.0202 Clean the lathe.

8.0203 Mount headstock and tailstock spindles.

8.0204 Check alignment of centers before mounting workpiece.

8.0205 Install drive plate on headstock spindle and a lathe dog of proper size on one end of workpiece.

8.0206 Lubricate center hole for tailstock center with white lead or a drop of heavy oil before mounting workpiece.

8.0207 Place tail of dog in faceplate so that workpiece rest firmly on headstock. Be sure tail of dog is not binding.

8.0208 Properly tighten tailstock center (not too much) so workpiece will not become hot and expand.

8.0209 Insert cutting tool in toolholder and clamp securely. Be sure toolholder does not extend out too are from tool post. Face of tool bit is set at center height.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.02 SET UP ENGINE LATHE FOR TURNING OPERATIONS

PERFORMANCE ACTIONS (Con't.):

8.0210 Turn toolholder so that cutting edge of tool is directed slightly toward tailstock end.

8.0211 Move carriage by hand to see that toolholder clears the dog so damage will not occur from revolving dog striking the compound rest.

PERFORMANCE STANDARDS:

- Set up engine lathe for turning operation using a faceplate and chuck.
- All components must be mechanically secure.
- The tool bit must be secured in the holder and set at the point of dead center on the stock.
- The faceplate and dog must be mounted so that the tailstock engages the stock in the center.
- The chuck must be mounted securely to the threaded spindle with the jaws tightened to hold the workpiece.
- Spindle threads must not be damaged and must be clean and free of chips or lint.
- Performance process must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Identify components of an engine lathe:
  a. headstock
  b. pulleys
  c. gear box
  d. drive motor
  e. bed and ways
  f. lead screw
  g. tailstock
  h. compound rest
  i. tool post
  j. apron
  k. toolholder and bit
  l. clutch knob
  m. feed change lever
  n. half-nut lever
  o. feed reverse lever
  p. back gear lever
  q. saddle
- Identify types of work-hold devices:
  a. faceplate
  b. three-jaw universal chuck
  c. four-jaw independent chuck
  d. collet chuck
  e. spindle chuck

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.02 SET UP ENGINE LATHE FOR TURNING OPERATIONS

RELATED TECHNICAL INFORMATION (Con't.):

- Identify types of lathe accessories:
  a. faceplate dogs
  b. mandrel
  c. faceplate straps and clamps
  d. lathe center
  e. steady rest
  f. follower rest
- Identify typical operations of engine lathe.
- Describe procedures for setting up a lathe with a faceplate and dog.
- Describe the procedure for setting up a lathe with (a) three- or (b) four-jaw chuck.
- Explain how a faceplate dog is attached to the faceplate and workpiece.
- Explain how chuck jaws are attached to the chuck.
- Safety precautions.

RELATED TRAINING:

1. Given specifications, correctly choose the appropriate tool for the lathe job and following correct procedures in grinding the tool to proper shape for use on the lathe to the instructor's standards:
   a. Grinding a lathe tool to proper shape and dimension.
   b. Selecting a tool for a specified job.
   c. Toolholders and tool post.
2. Given measuring tasks, follow correct procedures in using following tools to make measurements:
   a. Calipers (inside and outside).
   b. Micrometer.
   c. Snap and plug gages.
   d. Steel ruler.
   e. Depth gages.
3. Given appropriate tools, supplies, and equipment, mount and describe use of lathe attachments:
   a. Center rest.
   b. Follower rest.
   c. Taper attachment.
4. Calculate feeds and speeds.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.03 ALIGN LATHE CENTERS USING ACCURATE MEASUREMENT TECHNIQUES

PERFORMANCE OBJECTIVE:

Provided with a lathe and measuring instruments, align the lathe centers. Centers must be aligned with a tolerance of +/- 0.0005 inch.

PERFORMANCE ACTIONS:

8.0301 Differentiate between alignment by: (c, d, & e for accuracy)

a. Visually aligning center lines on ends of tailstock.
b. Visually aligning the points of the live and dead centers.
c. (Trial cut method) where a cut is taken at each end of work and finished diameters are checked with micrometer.
d. (Parallel test bar and dial indicator) a fast method of align lathe centers. (THIS METHOD WILL BE DESCRIBED FOR ILLUSTRATION)
e. (Micro-set adjustable center) constructed to permit center to be offset slightly.

9

8.0302 Align centers using a test bar and dial indicator:

a. Clean centers of lathe and test bar.
b. Mount test bar snugly between centers and tighten tailstock spindle clamp.
c. Mount a dial indicator in tool post or on the lathe carriage. (Contact point should be on center and indicator plunger should be in a horizontal position.)
d. Adjust cross-side so that indicator needle registers about one-half a revolution on diameter at tailstock end.
e. Move carriage to left by hand until indicator registers on diameter at headstock end. Note indicator reading.
f. If readings are not same, move carriage until indicator again registers at tailstock end.
g. Loosen tailstock clamp nut.
h. By means of tailstock adjusting screws, move tailstock in proper direction the difference between the indicator readings at the tailstock and headstock ends.

PERFORMANCE ACTIONS (Con't.):

i. Tighten loose adjusting screw to lock upper part of tailstock in place.
j. Tighten tailstock clamp nut and recheck to make sure that test bar still fits snugly between centers.
k. Repeat measuring and adjustment steps until indicator readings are same.

PERFORMANCE STANDARDS:

- Align lathe centers using accurate measurement techniques. (Demonstrate alignment of centers using test bar and dial indicator method.)
- Centers must be aligned with a tolerance of +/- 0.0005 inch.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.04 MOUNT WORKPIECE BETWEEN CENTERS

PERFORMANCE OBJECTIVE:

Given an engine lathe, pre-cut cylindrical stock with scribed centers, a faceplate and dog, combination drill and countersink, detail drawings, specifications, and the necessary tools, equipment, and materials; center drill the workpiece and mount it between the centers. The workpiece must be center drilled to specifications with a tolerance of +/- 0.005 inch for location, diameter, and depth. The workpiece must be mounted with the soft center in the live (headstock) center and the hardened center in the dead (tailstock) center to specifications. The tailstock must be fastened securely with room for the saddle and tool block to operate.

PERFORMANCE ACTIONS: (Dial indicator method)

8.0401 Distinguish between chalk method and (dial indicator method).

FOR DIAL INDICATOR METHOD:

8.0402 Attach a dial indicator to the lathe tool post or cross-side.

8.0403 Bring indicator into contact with center until it registers approximately one-quarter of a turn.

8.0504 Revolve the lathe spindle by hand and note indicator pointer.

8.0505 If center is not running true, indicator pointer shows a "runout."

8,0506 If runout is indicated, remove, clean, and replace center:

a. Stop lathe, remove center using a knockout bar.
b. Throughly clean the headstock spindle taper and the tapered shank of the center.
c. Remove any burrs from both tapers.
d. Replace center in headstock spindle with a sharp snap.

TASK EXPANSION: (True a live center when very close tolerances must be met.)

1. Securely hold piece of tool steel in a three or four-jaw chuck.

TASK EXPANSION (Con't.):

2. Swivel the compound rest 30 degrees to right or lathe centerline.
3. Rough turn center, feeding compound rest by hand.
4. Finish turn center with slow hand feed (hone tool before final cut).
5. Mount workpiece between centers.
6. Adjust lathe dog so that it is driven by the side of one of the chuck jaws.

PERFORMANCE STANDARDS:

- Mount given workpiece between centers by dial indicator method so that the workpiece is center drilled to specifications with a tolerance of +/- 0.005 inch for location, diameter, and depth.
- The workpiece must be mounted with the soft center in the live (headstock) center and the hardened center in the dead (tailstock) center to specifications.
- The tailstock must be fastened securely with room for the saddle and tool block to operate.

SUGGESTED INSTRUCTION TIME: 12 Hours .

RELATED TECHNICAL INFORMATION:

- Identify applications for mounting work between centers.
- Explain how to center drill a workpiece on the lathe.
- Calculate the feed and speed used for center drilling a workpiece on the lathe.
- Describe the procedure for mounting a workpiece between centers.
- Explain the purpose of a dead center and live center.
- Explain why lubrication of the dead center is necessary.
- Outline safety precautions.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.05 ALIGN WORKPIECE ON FACEPLATE

PERFORMANCE OBJECTIVE:

Given a workpiece, lathe, measuring tools, faceplate and all necessary accessories, tools, and materials; align the workpiece on the lathe faceplate with an accuracy of +/- 0.001 inch.

PERFORMANCE ACTIONS:

8.0501 Mount workpiece on faceplate:

a. Use straps or bolts.
b. Use counterbalance weight as necessary.

8.0502 Roughline line up workpiece:

a. Tighten clamps lightly.
b. Turn lathe by hand.

8.0503 Adjust workpiece using chalk or tool holder end.

8.0504 Mount indicator.

8.0505 Adjust workpiece to required accuracy using indicator:

a. Tap with soft hammer.
b. Tighten workpiece securely when aligned within tolerance.

PERFORMANCE STANDARDS:

- Align workpiece on faceplate with an accuracy of +/- 0.001 inch.

SUGGESTED INSTRUCTION TIME: 1 Hour

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.06 ALIGN WORKPIECE IN FOUR-JAW CHUCK

PERFORMANCE OBJECTIVE:

Furnished with workpiece, lathe, and measuring instruments, align workpiece in the four-jaw chuck with a tolerance of +/- 0.001 inch.

PERFORMANCE ACTIONS:

8.0601 Mount workpiece in four-jaw chuck using rings on face of chuck for rough alignment.

8.0602 Center workpiece with chalk using two oppositive jaws each adjustments:

- a. Mount toolholder in tool post.
- b. Rest chalk on toolholder.
- c. Rotate workpiece holding chalk against workpiece.
- d. Observe rings on face of chuck for concentricity.

8.0603 Mount indicator on tool post.

8.0604 Check one pair of possible jaws with indicator against workpiece.

8.0605 Adjust one-half of error.

8.0606 Check other opposite jaws and adjust one-half error.

8.0607 Repeat measuring and adjustment steps until workpiece is within tolerance and all jaws are tightened.

8.0608 Check tolerance.

PERFORMANCE STANDARDS:

- Align workpiece in four-jaw chuck with a tolerance of +/- 0.001 inch.

SUGGESTED INSTRUCTION TIME: 4 Hours

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.07 MAKE ROUGHING CUTS

PERFORMANCE OBJECTIVE:

Given an engine lathe with a mounted workpiece, a dimensioned drawing or blueprint, toolholder and roughing bit, and the necessary tools, measuring instruments, and materials; making roughed cuts of .010 inch per revolution. The workpiece must be roughed to size with 1/32 inch allowed for a finishing cut. When the workpiece is turned to within 1/2 inch of the dog or 1 inch of the chuck jaws, it must be removed and turned to rough dimensions.

PERFORMANCE ACTIONS:

8.0701 Clean centers. Place in headstock and tailstock spindles.

8.0702 Check alignment of centers before mounting workpiece.

8.0703 Install drive plate on headstock spindle and a lathe dog of the proper size on one end of workpiece.

8.0704 Lubricate center hole for tailstock center before mounting the workpiece. Place tail of dog in faceplate so workpiece rests firmly on headstock and checking to be sure the tail of the dog is not binding.

8.0705 Tighten tailstock properly, not too much so that workpiece might become hot and expand.

8.0706 Insert cutting tool in toolholder and clamp securely. Be sure toolholder does not extend out too far from tool post. Set the face of the tool bit at center height.

8.0707 Turn toolholder so that the cutting edge of the tool is directed slightly toward the tailstock end.

8.0708 Move carriage by hand to see that the toolholder clears the dog.

8.0709 Move carriage to tailstock end of workpiece. Turn in crossfeed until a chip starts to form.

8.0710 Calculate feed and speed.

PERFORMANCE ACTIONS (Con't.):

8.0711 Take a trial cut about 1/4 - 1/2 inch long and deep enough to true up the workpiece. Check diameter of workpiece.

8.0712 Start lathe. Throw in power longitudinal feed, and take first roughing cut.

8.0713 Make necessary roughing cuts, two or more, based on size (oversize) or workpiece.

8.0714 Watch for:

a. Dull cutting tool.
b. Workpiece or tool not rigid enough.
c. Too much overhand of tool or toolholder.

PERFORMANCE STANDARDS:

- Make roughing cuts of .010 inch per revolution with 1/32 inch allowed for finishing cut.
- When the workpiece is turned to within 1/2 inch of the dog or 1 inch of the chuck jaws, it must be removed and other end turned to rough dimensions.

SUGGESTED INSTRUCTION TIME: 24 Hours

RELATED TECHNICAL INFORMATION:

- Define roughing cut.
- Describe procedure for making roughing cuts on stock mounted between centers.
- Describe the procedure for making roughing cuts on stock mounted in a chuck.
- Identify tool bits used for roughing cuts.
- Explain how tool bit is positioned for roughing cuts.
- Explain how to measure a workpiece with calipers.
- Safety.
- Calculate feed and speed.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.08 MAKE FINISHING CUTS

PERFORMANCE OBJECTIVE:

Given an engine lathe with a rough cut workpiece mounted in a chuck or in a faceplate, a detail drawing, toolholder and finishing bit, and the necessary tools, equipment, and materials; make finishing cuts of .003 inch per revolution. The workpiece must be finished to size with a tolerance of +/- .003 inch.

PERFORMANCE ACTIONS:

8.0801 Remove work and roughing tool bit (unless roughing tool is in good condition and will be used for finish turning).

8.0802 Mount a finishing tool in the toolholder and adjust toolbit to center height.

8.0803 Set lathe speed and feed for finish turning. (The feed should be finer that that used for rough turning. A feed of approximately .005 is recommended.)

8.0804 Remount workpiece.

8.0805 Start machine and take a light +/- 1/4 inch long cut at right hand end of workpiece.

8.0806 Stop machine, measure diameter of trial cut, be sure not to move crossfeed hand or graduated collar setting.

8.0807 Move carriage to right until tool bit is clean of work.

8.0808 Using crossfeed handle, feed cutting tool in one-half the difference between trial cut diameter and the required finished diameter.

8.0809 Start machine, engage automatic feed, and take about a 1/4 inch long cut.

8.0810 Stop machine and recheck diameter for size.

8.0811 If diameter is required size, continue to cut to desired length.

PERFORMANCE STANDARDS:

- Process must be to instructor's standards and product must be to specifications.

SUGGESTED INSTRUCTION TIME: 20 Hours

UNIT	8.0	BASIC ENGINE LATHE WORK
TASK	8.09	TURN A WORKPIECE TO DIMENSIONS

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical stock, a detail drawing that required various diameters, toolholder and bits, and the necessary tools, measuring instruments, and materials; turn the workpiece to dimensions. The diameters and dimensions must meet specifications with a tolerance of +/- 0.005 inch.

PERFORMANCE ACTIONS:

FINISH TURNING:

8.0901 Insert properly ground and honed finishing tool in toolholder.

8.0902 Turn toolholder until cutting edge is slightly toward tailstock end so tool will not dig into workpiece.

8.0903 Place workpiece between centers and lubricate dead center.

8.0904 Using cross-feed, spot the tool on the workpiece. Feed a few thousands of an inch short of one-half the amount that the workpiece is oversize.

8.0905 Take a trial cut about 1/4 inch long. Measure diameter with micrometer.

8.0906 Move carriage to right of workpiece and set micrometer collar to zero on cross-feed screw. Set cross-feed for one-half of material to be removed. Make a trial cut and measure workpiece.

8.0907 Engage carriage feed. Finish first half of workpiece.

8.0908 Place strip of soft metal around finished end and replace dog.

8.0909 Turn other half of workpiece to size.

SHOULDER TURNING:

8.0910 Face right end of workpiece.

PERFORMANCE ACTIONS (Con't.):

8.0911 Using hemaphrodite caliper, lay off specified distance from faced end. Caliper is set to required distance on steel rule.

8.0912 Place right-hand roughing tool in toolholder.

8.0913 "Neck" workpiece as marked, and rough turn first diameter to 0.031 inch oversize.

8.0914 FILLET SHOULDER:

a. If shoulder is to be filleted, start tool 0.031 inch away from scribed line and feed it in far enough to undercut workpiece.
b. For finishing, grind required radius on finishing tool and place it in toolholder.
c. Adjust tool so that the small diameter and the shoulder can be completed at one setting.

8.0915 SQUARE SHOULDER:

a. For square shoulders, chalk workpiece and layout required distance. Scribe with hermaphrodite caliper.
b. Neck workpiece with parting tool to within +.-0/016 or required diameter.
c. Replace necking tool with a tool with a slight radius on the point.
d. Rough out small diameter to within 0.010 inch of size.
e. Replace roughing tool with finishing tool and finish the small diameter to size. Disengage power and feed last 0.062 inch by hand up to shoulder.
f. Turn cross-feed by hand to face shoulder square.

PERFORMANCE STANDARDS:

- Turn a workpiece to dimensions +/- 0.005 inch or specifications, demonstrating finish and shoulder turning as required.
- Performance process and product must be to instructor's standards.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.09 TURN A WORKPIECE TO DIMENSIONS
(Con't.)

SUGGESTED INSTRUCTION TIME: 20 Hours

RELATED TECHNICAL INFORMATION:

- Describe how to transfer measurements from a blueprint to the workpiece.
- Calculate the cutting speed and feed for turning a workpiece to various dimensions.
- Identify tool bits and positions used in turning a workpiece to dimensions.
- Describe procedure for turning a workpiece to dimensions.
- Describe how to test the accuracy of lathe center alignment by turning a workpiece at each end when mounted between centers.
- Principles of straight turning and turning to shoulders:
  a. Rough turning:
    (1) Tolerance
    (2) Setting the compound
    (3) Toolholder
    (4) Safety
    (5) Making trial cut to true up piece
    (6) Lubricating tail center
  b. Finish turning:
    (1) Selection of cutting tool
    (2) Use of micrometer
  c. Turning to shoulder:
    (1) Machining a piece to several different diameters
    (2) Square shoulder
    (3) Angular shoulder
    (4) Filleted shoulder
    (5) Undercut shoulder
    (6) Using fillet or radius gage

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.10 FACE A WORKPIECE TO DIMENSIONS

PERFORMANCE OBJECTIVE:

Given cylindrical stock, a detail drawing that required several facing operations, toolholder and bits, and the necessary tools, measuring instructions, and materials; face the workpiece to dimensions using the engine lathe so that the workpiece meets specifications with a tolerance of +/- 0.005 inch.

PERFORMANCE ACTIONS:

8.1001 Prepare lathe for facing operation. Assemble materials.

8.1002 Mount chuck on lathe spindle.

8.1003 Mount workpiece in chuck:

- a. Check for true running.
- b. Adjust for true running as necessary.
- c. Scribe line for length.

8.1004 Mount facing tool in toolholder.

8.1005 Adjust angle of toolholder and tool.

8.1006 Center tool to center of workpiece, vertically.

8.1007 Lock carriage to bed.

8.1008 Select and set speed and feed:

- a. Hand feed small workpiece.
- b. Power feed large workpiece.

8.1009 Face material removing 1/61 inch to 1/8 inch.

8.1010 Check to verify that ends are faced square to axis of work.

8.1011 Face to scribed line.

PERFORMANCE STANDARDS:

- Face a workpiece to dimensions +/- 0.005 inch on the engine lathe demonstrating recommended procedures.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.10 FACE A WORKPIECE TO DIMENSIONS (Con't.)

SUGGESTED INSTRUCTION TIME: 10 Hours

RELATED TECHNICAL INFORMATION:

- Identify priniciples of faceplate work.
- Identify faceplate work accessories:
  - End measuring rod
  - Square head bolt
  - Faceplate stud
  - U-clamp
  - Parallel
  - Parallel strip
  - Angle plate
  - Stop block
  - Trueing-up work on a faceplate
  - Counterbalancing
  - Mounting a workpiece on a faceplate using T-bolts and strap clamps.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.11 KNURL A WORKPIECE

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical stock, a detail drawing of a knurled part, knurling specifications, diamond and straight knurling tools, and the necessary tools, measuring instruments, and materials; knurl the workpiece to specifications using course, medium, and fine rollers as required. The knurl must meet specifications with a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS: (Steps may vary with actions 1-5 following 7-8.)

8.1101 Mount workpiece in lathe.

8.1102 Lay off length of knurl.

8.1103 Set lathe speed and feed to instructor's standards.

8.1104 Turn workpiece to O.D.

8.1105 Select knurling tool.

8.1106 Mount knurling tool in tool post.
(NOTE: "Lay off knurl" [may be accomplished at this time instead of above in step 2].)
Knurling tool should incline at slight angle toward headstock so right side of knurls touch workpiece first.

8.1107 Move carriage to tailstock end of workpiece.

8.1108 Place lathe in back gears and start lathe on slow speed.

8.1109 Start lathe and feed knurl into workpiece:

a. With the hand cross-feed, force rollers about 0.016 inch into workpiece.
b. Engage longitudinal power feed.
c. Allow knurling tool to travel across workpiece for about 0.250 inch.
d. With brush, apply oil to knurls.

8.1110 Stop operations, check pattern, adjust as required.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.11 KNURL A WORKPIECE

PERFORMANCE ACTIONS (Con't.):

8.1111 Increase pressure on wheels and continue knurling.

8.1112 Stop lathe when left end of knurling tool reaches left end of stock.

8.1113 Reverse travel of carriage. Apply pressure to knurls with cross-feed.

8.1114 Engage longitudinal feed and all tool to feed toward tailstock end.

8.1115 Repeat operation until desired knurl depth is obtained.

8.1116 Clean knurl and measure workpiece.

PERFORMANCE STANDARDS:

- Knurl a workpiece to specifications with a tolerance of +/- 1/64 inch using proper rollers/wheels to produce desired pattern.
- Performance procedures and product must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Identify knurling.
- Identify knurling patterns:
    a. Diamond
    b. Straight
- Identify knurling toolholders:
    a. Knuckle-joint holder
    b. Revolving head holder
    c. Staddle holder
- Mounting/holding work.
- Lubrication.
- Cleaning knurls.
- Knurl cutting tool.
- Safety.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.12 DRILL HOLES WITH LATHE

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical parts, a detail drawing of parts to be drilled, drilling specifications, a drill chuck and drill bits, and the necessary tools, measuring instruments, and materials; drill holes in the parts using the lathe tailstock. The holes must be drilled to specifications with a tolerance of +/- .003 inch for location,
+ .002 inch for diameter, and +/- 1/64 inch for depth.
- .000 inch

PERFORMANCE ACTIONS:

8.1201 Mount workpiece in lathe chuck.

8.1202 Select and set speed.

8.1203 Face and center drill workpiece.

8.1204 Select drill (size with drill gage).

8.1205 Drill workpiece to specifications:

a. Apply lubricant as required.
b. Check depth required.
c. Use tailstock spindle graduations for depth adjustment.
d. Measure depth with narrow rule.

8.1206 Measure drilled hole.

PERFORMANCE STANDARDS:

- Drill holes with lathe to specifications or a tolerance of +/- .003 inch for location; +/- .002, -.000 inch for diameter; and +/- 1/64 inch for depth.
- Performance process and product must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: 10 Hours

RELATED TECHNICAL INFORMATION:

- Demonstrate mounting of straight-shank drills in lathe.
- Calculate cutting speed for drilling operation.
- Describe/demonstrate procedure for drilling holes on the lathe (pilot drilling, lathe dog, alignment, reaming).
- Explain why cutting fluid is necessary when performing a drilling operation.
- Safety.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.13 REAM HOLES ON THE LATHE

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical parts, a detailed drawing of drilled holes to be reamed, reaming specifications, a drill chuck and reaming tools, and the necessary tools, measuring instruments, and materials; ream the drilled holes using the lathe tailstock. The holes must be reamed to specifications with a tolerance of $\frac{+0.005 \text{ inch}}{-0.000 \text{ inch}}$.

PERFORMANCE ACTIONS:

8.1301 Assemble workpiece and identify hole diameter.

8.1302 Set lathe speed for drilling.

8.1303 Mount workpiece in lathe.

8.1304 Mount drill chuck and center drill in tailstock of lathe.

8.1305 Set lathe speed.

8.1306 Start lathe and face workpiece.

8.1307 Center drill workpiece.

8.1308 Select drill:

a. Drill hole undersize.
b. Step drill.

8.1309 Select reamer.

8.1310 Set lathe speed to one-half drilling speed.

8.1311 Ream hole in workpiece using lubricant as required:

a. Mount reamer in tailstock drill chuck.
b. Feed reamer into drilled hole at moderate rate.

8.1312 Measure hole and check with plug gage.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.13 REAM HOLES ON THE LATHE (Con't.)

PERFORMANCE STANDARDS:

- Ream holes on the lathe to specifications with a tolerance of
  + 0.0005 inch.
  - 0.0000 inch

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Explain/demonstrate mounting of reaming tools in lathe.
- Identify types and sizes of reamers.
- Calculate cutting speed for a reaming operation.
- Describe procedure for reaming holes on a lathe.
- Explain why reamer must be withdrawn to remove metal chips when reaming a deep hole.
- Safety.
- *Machinery's Handbook*.
- Use of vernier micrometer caliper, hole gage, plug gage.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.14 BORE HOLES

PERFORMANCE OBJECTIVE:

Given an engine lathe, pre-cut cylindrical stock with undersized-drilled holes, an assortment of boring tools, a detail drawing, boring specifications, and the necessary tools, measuring instruments, and materials, bore holes using a steady rest attachment. The holes must be bored to specifications with a tolerance of +/- .001 inch for location, diameter, and depth, and +/- 1 degree for perpendicularity.

PERFORMANCE ACTIONS:

8.1401 Center workpiece in chuck, allowing proper clearance to protect chuck from boring tool.

8.1402 Select tool that will clear hole and will be short enough to eliminate any springing actions.

8.1403 Set boring bar in tool post parallel with axis of rotation and with cutting edge as a center.

8.1404 Move carriage and cross-feed slide to correct position, with cutting edge of tool in the hole.

8.1405 Adjust lathe for same spindle speed and feed as for turning.

8.1406 Set dial on cross-feed slide to zero. Turn on power and engage the carriage feed. Take a light cut to "straighten" the hole.

8.1407 Disengage carriage feed and stop the spindle. Back tool out of bored hole without disturbing cross-feed setting.

8.1408 Check hole for size with an inside caliper or a telescoping gage.

8.1409 Start spindle. Then, with handwheel, move tool to workpiece and engage carriage feed. Take the cut or take several cuts if there is a good bit of metal to remove.

8.1410 Regrind the tool for the finishing cut. Check hole for "bellmouthing" (Where mouth of hole is larger than interior).

PERFORMANCE STANDARDS:

- Bore holes in cylindrical stock on the lathe meeting specifications with a tolerance of +/- .001 inch for location, diameter, and depth, and +/- 1 degree for perpendicularity.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Describe boring.
- Identify methods of boring.
- Describe why a drilled hole must be bored.
- Select forged boring tool(s).
- Identify boring bar holder.
- Use measuring tools.
- Identify chatter and vibration.
- Identify through-boring.
- Safety.

EXPANSION OF TASK:

- Taper boring.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.15 COUNTERBORE HOLES

PERFORMANCE OBJECTIVE:

Given an engine lathe, pre-cut cylindrical stock with bored holes, an assortment of counterboring tools, a detail drawing, counterboring specifications, and the necessary tools, attachments, measuring instruments, and the materials; counterbore the holes. The holes must be counterbored to specifications with a tolerance of +/- 0.001 inch.

PERFORMANCE ACTIONS:

8.1501 Set spindle speed for diameter of counterbored hole.

8.1502 Using regular boring tool mounted in the 90 degree hole in the boring bar, rough out the hole within 1/32 inch of the finished diameter and depth.

8.1503 Mount a suitably ground finishing tool in the 45 degree hole in the boring bar.

8.1504 Start the machine, feed the boring tool until it touches the internal diameter, and note the graduated collar setting.

8.1505 Face (square) the internal shoulder, taking successive cuts from the center outwards. The cross-feed hand should be turned counterclockwise to the original setting plus .020 to provide a slight undercut at the shoulder. Where the depth of should must be accurate, set compound rest 90 degrees to cross-slide and use compound rest collar to gage depth.

8.1506 Take light trial cut about 1/8 inch long at start of hole.

8.1507 Stop machine and check diameter of counterbore.

8.1508 Set boring tool to finished diameter, using cross-feed graduated collar.

8.1509 Start machine, take trial cut, and recheck diameter.

8.1510 Machine internal diameter to the shoulder finishing bore to specified dimensions.

PERFORMANCE STANDARDS:

- Counterbore holes to specifications with a tolerance of +/- 0.001 inch using the engine lathe.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Mount boring bar: Select largest bar possible.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.16 COUNTERSINK HOLES USING THE LATHE

PERFORMANCE OBJECTIVE:

Provided with an engine lathe, measuring instruments, an assortment of countersinking tools, detail drawings, countersinking specifications, and the necessary tools, attachments, and materials as well as pre-cut cylindrical stock with bored holes; countersink the holes. The holes must be countersunk to specifications.

PERFORMANCE ACTIONS: (Using Countersink Cutter.)

8.1601 Check workpiece in lathe.

8.1602 Select and set lathe speed.

8.1603 Face and square workpiece.

8.1604 Center drill workpiece.

8.1605 Drill workpiece.

8.1606 Countersink to specifications:

a. Lubricate as necessary.
b. Reduce speed.
c. Set stop as required.
d. Check measurements during operations.

PERFORMANCE STANDARDS:

- Countersink holes using the lathe to specifications.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Identify applications for countersinking holes on the engine lathe.
- Calculate cutting speed for countersinking operation.
- Explain why cutting fluid is necessary when countersinking a hole.
- Describe procedure for countersinking a hole.
- Explain how to precision measure a countersunk hole.
- Safety.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.17 TAP HOLES

PERFORMANCE OBJECTIVE:

Given an engine lathe, pre-cut cylindrical or rectangular stock with drilled holes, detail drawings, tapping specifications, machine taps, and necessary tools, attachments, measuring instruments, and materials; tap required holes in the stock. The tapped holes must be threaded to specifications.

PERFORMANCE ACTIONS:

8.1701 Mount workpiece in lathe.

8.1702 Face and square workpiece.

8.1703 Center drill workpiece.

8.1704 Drill hole with tap drill.

8.1705 Chamfer hole.

8.1706 Select and secure taper tap and tap wrench.

8.1707 Mount center in tailstock.

8.1708 Start tap in hole (hold tailstock center against end of tap).

8.1709 Tap hole in workpiece:

  a. Apply lubricant.
  b. Back tap occasionally to break chips.
  c. Clean out chips.

8.1710 Tap with plug and bottom taps.

8.1711 Clean out tapped hole.

8.1712 Measure hole for specifications.

PERFORMANCE STANDARDS:

- Tap required holes in given stock to given specifications.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify applications for tapping a hole on a lathe.
- Calculate the cutting speed for a tapping operation.
- Describe procedure for tapping a hole on a lathe.
- Explain how to use a plug gage to measure the tapped hole.
- Machinery's Handbook.
- Safety considerations.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.18 CUT GROOVES OR RECESS

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical stock, a detail drawing that requires several recesses or grooves (v-shaped, square, and round), grooves or neck specifications, toolholder and tool bits, and the necessary tools, measuring instruments, and materials; turn the grooves or necks specified for the stock with a tolerance of +/- .005 inch.

PERFORMANCE ACTIONS:

CUTTING A GROOVE OR RECESS

8.1801 Review specifications, assemble materials, and set up lathe.

8.1802 Select proper shaped tool bit for groove or recess to be cut.

8.1803 Set tool in toolholder at right angle to workpiece.

8.1804 Feed tool into workpiece slowly, with reduced spindle speed.

8.1805 Recess by machining a groove on the inside of a hole with a square-nose boring tool.

PERFORMANCE STANDARDS:

- Turn grooves or necks in given stock to specifications +/- .005 inch so that the v-shaped, square, or round grooves or necks meet the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Define neck.
- Identify recesses, grooves, and necks from a blueprint or drawing.
- Calculate cutting speeds and feed for necking operations.
- Explain how cutting fluid is used in necking.
- Identify necking tool bits used for various grooving operations.
- Describe procedure for turning a groove or neck.
- Identify safety considerations.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.19 MACHINE AN EXTERNAL CHAMFER

PERFORMANCE OBJECTIVE:

Provided with an engine lathe, cylindrical stock, a detail drawing that required an external chamfer, toolholder and bits, and the necessary tools, measuring instruments, and materials; machine an external chamfer on the stock. The chamfer must be machined to specifications with a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS: (To be described by instructor.)

PERFORMANCE STANDARDS:

- Machine an external chamfer on the engine lathe to specifications within 1/64 inch.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify external chamfer from blueprints or drawing.
- Calculate cutting speed and feed for machining an external chamfer on a workpiece.
- Describe the procedure for machining an external chamfer.
- Explain how to precision measure the chamfer.
- Safety considerations.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.20 MACHINE AN INTERNAL CHAMFER

PERFORMANCE OBJECTIVE:

Provided with an engine lathe, cylindrical stock, a detail drawing that required an internal chamfer, toolholder and bits, and the necessary tools, measuring instruments, and materials; machine an internal chamfer in the stock. The chamfer must be machined to specifications within +/- 1/64 inch.

PERFORMANCE ACTIONS: (To be described by instructor.)

PERFORMANCE STANDARDS:

- Machine an internal chamfer to specifications within +/- 1/64 inch using the engine lathe.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify internal chamfer from a blueprint or drawing.
- Calculate cutting speed and feed for machining an internal chamfer in a workpiece.
- Describe procedure for machining an internal chamfer.
- Explain how to precision measure an internal chamfer.
- Safety considerations.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.21 PART WORKPIECES

PERFORMANCE OBJECTIVE:

Provided with an engine lathe, cylindrical workpieces requiring parting, detail drawings, parting specifications, toolholder and parting tools, and the necessary tools, measuring instruments, and materials; part the workpieces to specifications with a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

8.2101 Place workpiece in chuck or collet.

8.2102 Select and mount a parting (cutting-off) tool in a securely fastened toolholder.

8.2103 Set tool so cutting edge is on center and at right angle to workpiece and lock tool in position.

8.2104 Properly center tool to workpiece to be cut.

8.2105 Adjust lathe to proper speed for parting.

8.2106 Mark location of cut with chalk or layout dye.

8.2107 Feed cutting tool into workpiece slowly and steadily applying cutting oil as appropriate.

PERFORMANCE STANDARDS:

- Part workpieces on the engine lathe with a tolerance of +/- 1/64 inch of specifications.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Identify various parting tools and their applications.
- Describe the procedure for parting a workpiece.
- Calculate the cutting speed and feed for parting a workpiece.
- Explain how cutting fluid is used in parting a workpiece.
- Explain how to precision measure a parted workpiece.
- Explain how to surface finish a parted workpiece.
- Lubrication.
- Identify necessary safety consideration.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.22 FILE WORKPIECES

PERFORMANCE OBJECTIVE:

Provided with an engine lathe, cylindrical workpieces requiring filing, detail drawings, surface finish specifications in micro-inches, an assortment of files, and the necessary tools, measuring instruments, and materials; file the workpieces to specifications for surface finish.

PERFORMANCE ACTIONS:

8.2201 Review surface finish specification.

8.2202 Set up lathe and assemble materials.

8.2203 Select a single-cut mill file or an appropriate file for the task.

8.2204 Set spindle speed about twice the rpm for rough turning.

8.2205 Loosen dead center slightly and lubricate the center.

8.2206 Move carriage out of way toward right and remove tool post.

8.2207 Chalk file to prevent clogging and move file at slight angle to workpiece with uniform forward strokes starting near headstock. (Toward headstock on left hand filing of small workpiece. Excess pressure may cause workpiece to become out of round.)

8.2208 Keep file clean using file card as necessary.

PERFORMANCE STANDARDS:

- File workpieces to specifications producing the desired surface finish.
- Process and product performance must meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Describe precision measuring requirements to meet specifications.
- Identify symbols and notations for surface finish on blueprints or drawings.
- Explain why all machined surfaces have irregularities.
- Describe the procedure for filing a workpiece.
- Explain how to use a file on turning stock in a lathe.
- Identify surface finished which require filing and those which require polishing.
- Explain necessary safety considerations.

UNIT 8.0 BASIC ENGINE LATHE WORK

TASK 8.23 POLISH WORKPIECES

PERFORMANCE OBJECTIVE:

Given an engine lathe, cylindrical workpieces that have been filed, detail drawings, surface finish specifications in micro-inches, and assortment of abrasives, and the necessary tools, measuring instruments, and materials; polish workpieces to specifications for surface finish.

PERFORMANCE ACTIONS:

8.2301 Review specifications concerning surface finish.

8.2302 Set up lathe and materials and workpiece for polishing.

8.2303 Place workpiece between centers and lubricate them.

8.2304 Set lathe RPM about four times speed for turning.

8.2305 Disengage feed rod and lead screw.

8.2306 Place abrasive cloth over a file, or wrap the cloth around the workpiece holding the ends.

8.2307 Move the abrasive cloth back and forth on the workpiece.

8.2308 Polish to desired finish.

PERFORMANCE STANDARDS:

- Polish workpiece using proper technique for job so that specifications for surface finish are met.

SUGGESTED INSTRUCTION TIME: 5 Hours

RELATED TECHNICAL INFORMATION:

- Identify types of abrasives used for polishing workpieces to .0005 inch, 125 micro-inches, 75 micro-inches, 63 micro-inches, and 32 micro-inches.
- Explain how to use precision measuring equipment to determine surface finish (vernier micrometer caliper).
- Describe procedure for polishing a workpiece on the lathe.
- Explain use of abrasives.
- Identify safety considerations.

This page precedes Task 8.24

ADVANCED ENGINE LATHE WORK

The following tasks, 8.24 - 8.29, which represent Advanced Engine Lathe training typically will be introduced during the second year of training. The instructional time represented by these task objectives has been included in the second year plan for the secondary level Machine Shop program. For the purpose of organization and to represent the typical order of learning development, basic and advanced engine lathe objectives are not separated.

The second year description of Machine Shop will include a "comment" to identify that Advanced Engine Lathe training is included in the second year "instructional time plan" and to refer the student, instructor, or others to the second year tasks described in Unit 8.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.24 GRIND WORKPIECE WITH TOOL POST GRINDER

PERFORMANCE OBJECTIVE:

Provided with blueprint, workpiece, lathe and accessories including tool post grinder; grind workpiece with tool post grinder. Work must meet blueprint specifications with a tolerance of +/- 0.0005 inch.

(NOTE: Grinding on lathe should be performed only if a cylindrical grinder is not available or when a small grinding operation does not justify setting up the cylindrical grinder.)

PERFORMANCE ACTIONS:

8.2401 Obtain and mount tool post grinder.

8.2402 a. Check wheel, dress if necessary.
b. Mount wheel guard.
c. Take safety precautions.

8.2403 Mount workpiece in lathe.

8.2404 Protect lathe from grinding dust.

8.2405 Calculate and set lathe speed (e.g., 80-100 rpm).

8.2406 Set feed on lathe (0.005 inch to 0.007 inch).

8.2407 Turn on power of lathe and grinder.

8.2408 Engage workpiece with grinder (workpiece turning into grinding wheel).

8.2409 Engage longitudinal feed and grind workpiece to specifications.

8.2410 Measure workpiece with micrometer.

8.2411 Check for taper and adjust as necessary.

8.2412 Continue light grinding to obtain specifications.

PERFORMANCE STANDARDS:

- Grind workpiece with tool post grinder to specifications within a tolerance of +/- 0.0005 inch.
- Meet instructor's standards for performance and product.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Describe how to dress the wheel.
- Identify (orientation to) procedure for External Grinding.
- Identify (orientation to) procedure for Internal Grinding.
- Identify (orientation to) procedure for Grinding a Lathe Center.
- Describe how to increase and decrease work speed.
- Describe how to increase and decrease wheel speed.
- Describe/demonstrate how to align centers.
- Watch for fire hazard in using cloth covers on lathes.

UNIT	8.0	ADVANCED ENGINE LATHE (1st or 2nd Year Task)
TASK	8.25	MACHINE EXTERNAL TAPER

PERFORMANCE OBJECTIVE:

Provided with the engine lathe, workpiece, detail drawing requiring external taper, tapering attachment, taper specifications, toolholder and tool bits, and necessary hand tools, measuring instruments, and materials; machine external taper using tailstock setover method of the tapering attachment. The taper must be machined to specifications with a tolerance of .001 inch per 4 inches.

PERFORMANCE ACTIONS:

8.2501 Chuck workpiece on lathe.

8.2501 Select and set speed.

8.2503 Face and center drill workpiece.

8.2504 Secure workpiece between centers.

8.2505 Set taper attachment:

- a. Position taper attachment allowing for length of taper and clamp.
- b. Set attachment for taper required.
- c. Position tool on center height of workpiece.
- d. Engage feed 1/2 inch before start of cut (watch for backlash).

8.2506 Make roughing cut.

8.2507 Measure workpiece and make required adjustments.

8.2508 Check workpiece with gages.*

8.2509 Finish to specifications.

* GO/NO GO Taper Ring Gage.

PERFORMANCE STANDARDS:

- Machine external taper to specifications with tolerance of .001 inch per 4 inches using tailstock setover method of taper attachment.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.25 MACHINE EXTERNAL TAPER (Con't.)

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Describe how to set up external tapering operation using tailstock setover method.
- Explain how to set up an external tapering operation using tapering attachment.
- Outline procedures for machining external taper.
- Calculate curring speed and feed for machine external taper.
- Demonstrate how to precision measure external taper.
- Identify safety considerations.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.26 MACHINE INTERNAL TAPER

PERFORMANCE OBJECTIVE:

Using the engine lathe and provided workpiece, detail drawing requiring internal taper, tapering attachment, taper specifications, toolholder and tool bits, and the necessary hand tools, measuring instruments, and materials; machine internal taper with attachment meeting specifications with a tolerance of .001 inch per 4 inches.

PERFORMANCE ACTIONS:

8.2601 Calculate taper for taper attachment from reference.

8.2602 Chuck workpiece in lathe.

8.2603 True workpiece with dial indicator.

8.2604 Select and set speeds as necessary.

8.2605 Center drill workpiece.

8.2606 Step drill to blueprint specifications.

8.2607 Mount boring bar holder and boring bar with tool on compound rest.

8.2608 Adjust lathe taper attachment:

a. Set swivel bar.
b. Tighten binding screw.
c. Check cross slide.
d. Lubricate taper attachment.

8.2609 Position boring bar and tool to blueprint specifications (set center height).

8.2610 Turn taper and check for accuracy.

8.2611 Take additional cuts, checking workpiece.

8.2612 Finish cut to specifications.

PERFORMANCE STANDARDS:

- Machine internal taper with tapering attachment meeting specifications with a tolerance of .001 inch per 4 inches.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.26 MACHINE INTERNAL TAPER (Con't.)

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Explain the set up for internal tapering using the tapering attachment.
- Identify plain and telescoping taper attachments.
- Identify applications for internal tapers.
- Describe procedure for machining an internal taper.
- Calculate curring speed and feed for machining internal taper.
- Describe/demonstrate precision measuring of internal taper.
- Explain use of Tapered Plug Gage or equivalent measuring instrument.
- Machinery's Handbook.

UNIT	8.0	ADVANCED ENGINE LATHE (1st or 2nd Year Task)
TASK	8.27	MACHINE EXTERNAL ANGLE

PERFORMANCE OBJECTIVE:

Given the engine lathe, a workpiece set up for machining an external angle, a detail drawing, angle specifications, toolholder and tool bits, and the necessary hand tools, measuring instruments, and materials; machine the external angle using the compound rest method. The angle must be machined to specifications with a tolerance of +/- 30 minutes for the angle and +/- .001 inch for the diameters.

PERFORMANCE ACTIONS: (To be identified by instructor.)

PERFORMANCE STANDARDS:

- Machine external angle using compound rest method meeting specifications with a tolerance of +/- 30 minutes for the angle and +/- .001 inch for the diameter.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify applications for cutting external angle.
- Describe how to set up the workpiece and compound rest to machine an external angle.
- Describe procedure for machining external angle using compound rest.
- Calculate cutting speed and feed for machining external angle.
- Explain/demonstrate how to precision measure external angle.
- Identify safety considerations.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.28 MACHINE INTERNAL ANGLE

PERFORMANCE OBJECTIVE:

Provided with the engine lathe, workpiece set up for machining an internal angle, detail drawing, angle specifications, toolholder and tool bits, and necessary hand tools, measuring instruments, and materials; machine internal angle using compound rest method to specifications with tolerance of +/- 30 minutes for angle and +/- .010 inch for diameter.

PERFORMANCE ACTIONS: (To be identified by instructor.)

PERFORMANCE STANDARDS:

- Machine internal angle using compound rest method to specifications with tolerance +/- 30 minutes for angle and +/- .101 inch for diameter.

SUGGESTED INSTRUCTION TIME: 1 Hour

RELATED TECHNICAL INFORMATION:

- Identify applications for cutting internal angle.
- Explain/demonstrate how to set up workpiece and compound rest.
- Describe/demonstrate procedures for machining internal angle.
- Explain precision measuring internal angle.
- Identify safety considerations.

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.29 SET UP LATHE FOR THREADING OPERATIONS

(NOTE: This task is expanded to include threading operations.)

PERFORMANCE OBJECTIVE:

Given the requirement for various threading operations on the engine lathe, a faceplate and dogs, a universal or independent chuck, pre-cut cylinderical stock, toolholder, and single point tool bits, and the necessary hand tools, measuring instruments, and materials; set up the engine lathe for threading operations. All components must be mechanically secure. The tool bit must be secured in the toolholder and set square with the workpiece. The thread chasing dial must be positioned for specified threading operations including even, odd, and fractional divisions. The end of each workpiece must be chamfered with the side of the threading tool to .005 inch below minor diameter of the thread.

PERFORMANCE ACTIONS:

As a standard for actions, See: Krar, S. F., and J. W. Oswald, Turning Technology, Engine & Turret Lathes, Delmar Publishers Inc., pp. 126-142 (Chapter 21, Thread Cutting), 1971.

p. 127, Setting up Lathe for Cutting Right-hand Thread (National Form or Unified)
p. 132, Cutting a Left-hand Thread
p. 133, Cutting a Right-hand Acme Thread
p. 134, Cutting a Square Thread
p. 138, Cutting a Multiple Thread Using the Compound Rest Method

PERFORMANCE STANDARDS:

- Set up lathe for threading operations.
- All components must be mechanically secure.
- The tool bit must be secured in the toolholder and set square with the workpiece.
- The thread chasing dial must be positioned for specified threading operations including even, odd, and fractional divisions.
- The end of each workpiece must be chamfered with the side of the threading tool to .005 inch below minor diameter of the thread.

SUGGESTED INSTRUCTION TIME: 12 Hours

UNIT 8.0 ADVANCED ENGINE LATHE (1st or 2nd Year Task)

TASK 8.29 SET UP LATHE FOR THREADING OPERATIONS (Con't.)

RELATED TECHNICAL INFORMATION:

- Identify/define:
  - Screw thread
  - External thread
  - Internal thread
  - Major diameter
  - Minor diameter
  - Pitch diameter
  - TPI
  - Lead
  - Root
  - Crest
  - Flank or side
  - Thread depth
  - Thread angle
  - Helix or lead angle
  - Right hand thread
  - Left hand thread
- Machinery's Handbook.
- Calculate feeds and speeds.
- Identify safety considerations.

EXPANSION OF TASK: ADVANCED ENGINE LATHE - THREADING OPERATIONS

1. COMPUTER AMERICAN NATIONAL THREAD FORM

   Given basic dimensions for American National Form threads, compute the following:
   - Pitch
   - Pitch diameter
   - Major diameter
   - Minor or root diameter
   - Root and crest flats
   - Single depth
   - Double depth

2. COMPUTER SHAPE N-THREAD FORMULAS

   Given screw pitch which has sharp V-thread dimensions and appropriate measuring tools, compute the following:
   - Thread angle
   - Pitch
   - Depth
   - Minor diameter
   - Pitch diameter
   - Major diameter

3. IDENTIFY ACME THREADS

   Given screw or bolt with an acme thread form and appropriate gages, measure screw or bolt and identify pitch, depth, and width of threads.

EXPANSION OF TASK (Con't.):

4. IDENTIFY CLASSES OF FITS OF SCREW THREADS

Provided specifications and selection of threads bolts, correctly identify screw thread classifications and identify general application of the type of screw thread.

- Classes: 1A, 2A, 3A, and 1B, 2B, 3B
- Unified National Course (UNC), Fine (UNF), and Special (UNS).
- Fitting requirements.

5. IDENTIFY SQUARE THREADS

Provided with a square threaded bolt and measuring tools, calculate the pitch, width, and depth of the square thread.

- Identify depth verses pitch.
- Identify flank clearance.
- Identify clearance on major diameter.
- Figure thickness.
- Figure pitch, width, and depth.

6. USE THREAD MICROMETER (If applicable)

Measure with given thread micrometer the given sizes of threads accurately meeting instructor's standards.

- Identify purpose, parts, and accuracy of thread micrometer.
- Describe/demonstrate use of thread micrometer: Points of measurement and reading on scales.

7. MEASURE THREADS WITH THREE-WIRE METHOD (Optional)

Given three-wire gage set and assigned set of bolts or similar threaded items, accurately gage the threads of the items using the three-wire method. Meet instructor's standards.

- Figure "best wire size."
- Figure pitch diameter with three-wire method.

8. CHASE EXTERNAL UNIFIED THREADS

Given the engine lathe, cylindrical stock, a detail drawing that required right- or left-hand external unified threads, thread specifications, a toolholder and single point threading tool bits, and the necessary hand tools, measuring instruments, and materials; chase external unified threads on stock. Threads must be cut to

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EXPANSION OF TASK (Con't.):

specifications according to tolerances in Machinery's Handbook for class and fit.

- Machinery's Handbook (classes and fits).
- Set up requirements for chasing right-hand or left-hand unified threads.
- Procedures for chasing external unified threads.
- Measuring external threads.
- Use of cutting fluid in threading operation.
- Safety considerations.

9. CHASE INTERNAL UNIFIED THREADS

Provided with the engine lathe, cylindrical stock a detailed drawing that requires right- or left-hand internal unified threads, thread specifications, a toolholder and single point threading tool bits, and the necessary hand tools, measuring instruments, and materials, chase the internal unified threads in the stock. The threads must be cut to specifications in accordance with the tolerances given in Machinery's Handbook for class and fit.

- Machinery's Handbook.
- Set up requirements for chasing right- and left-hand internal unified threads.
- Procedures for chasing internal threads.
- Precision measuring of internal unified threads.
- Safety.

10. RESET A THREADING TOOL

Given engine lathe with partially threaded workpiece, detail drawing, thread specifications, toolholder, and single point threading tool bits, and necessary hand tools, measuring instruments, and materials; reset threading tool to pick up lead on unified external threads. Workpiece must be threaded to specifications without changing pitch diameter +/- .002 inch.

- Describe how to engage split-nut lever.
- Demonstrate method for feeding tool bit into thread groove.
- Procedures for resetting threading tool.
- Safety considerations.

(NOTE: As task objects expand, they merge with post-secondary training objectives.)

UNIT 9.0

BASIC AND ADVANCED MILL WORK

Basic Mill Work is designed to introduce the student to mill work and provide the fundamental skills essential to the basic use of the milling machine.

Advanced Mill Work designed to expand the student's competencies at a more difficult level.

Basic and Advanced Mill Work may be combined during the first year of instruction or may be distributed over two years of training to obtain the most effective and efficient training results.

MACHINE SHOP
BASIC AND ADVANCED MILL WORK
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 9.0	BASIC AND ADVANCED MILL WORK	
9.01	Inspect and Clean a Milling Machine	3
9.02	Identify Milling Machine Work Holding Devices and Their Functions	6
9.03	Align Workpiece Mounted on Machine Table	2
9.04	Align Mill Head to Table	2
9.05	Align Milling Machine Attachments	2
9.06	Align Milling Machine Fixtures With Indicator	2
9.07	Calculate Cutting Speeds and Feeds for Milling Machine Work	3
9.08	Face Mill Workpiece	3
9.09	Perform Side Milling Operation	6
9.10	Perform Angular Milling Operation	3
9.11	Perform End Milling Operation	21
9.12	Drill, Bore, and Ream Holes	12
9.13	Perform Keyseating and T-Slot Milling Operation	9
9.14	Cut Slots With Milling Machine (Slitting Operation)	6
	TOTAL HOURS (FIRST YEAR)	80

ADVANCED MILL WORK
(SECOND YEAR)

9.15	Perform Indexing Operations	20
9.16	Perform Graduating and Marking Operations	3
9.17	Identify Types of Gears and Their Functions	3
9.18	Calculate Pitch, Diameters, Working Depth and Clearances for Machining Gears	9
9.19	Mill a Gear Rack	12
9.20	Machine a Spur Gear	6
	TOTAL HOURS (SECOND YEAR)	53

TOTAL HOURS OF MILL WORK INSTRUCTIONAL TIME: 133

UNIT/TASK	DESCRIPTION
Unit 9.0	BASIC AND ADVANCED MILL WORK
9.01	(Inspect and Clean a Milling Machine) Provided with a milling machine (horizontal or vertical), operator's manual, cleaning materials, and the necessary instruction, hand tools, and equipment; inspect and clean the milling machine according to the manufacturer's (or instructor's) information. The milling machine and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.
9.02	(Identify Milling Machine Work Holding Devices and Their Functions) Given a shop milling machine and work holding devices and proper instruction; accurately identify each device and describe the type of work for which the device is designed.
9.03	(Align Workpiece Mounted on Machine Table) Given milling machine, blueprint (drawing), workpiece, and measuring instruments; align workpiece on machine table to a tolerance of 0.001 inch total indicator run out.
9.04	(Align Mill Head to Table) Given the ram and turret milling machine and measuring instruments, align the head with the table to a tolerance of +/- 0.0005 inch.
9.05	(Align Milling Machine Attachments) Given milling machine with attachments, measuring instruments, hand tools and materials; align attachments to a tolerance of 0.001 inch run out at 4 inches.
9.06	(Align Milling Machine Fixtures with Indicator) Given a milling vise, clamping bolts, wrench, dial indicator, mallet, and square; align the fixture on the milling machine tool to within +/- 0.001 inch total run out.
9.07	(Calculate Cutting Speeds and Feeds for Milling Machine Work) Given a milling machine and accessories, workstock, work assignment, and necessary tools and materials; select proper cutter and attachment, calculate speed and feed, and install the cutter. Performance must conform to the Machinery's Handbook.
9.08	(Face Mill Workpiece) Given a milling machine with workpiece mounted in a jig, detail drawing or blueprint, facing specifications, an assortment or arbors, collars, and milling

cutters, and the necessary hand tools, measuring instruments, and materials; face mill the workpiece to specifications to a tolerance of +/- 0.001 inch. Finished work must be smooth without gouges or marks.

9.09 (Perform Side Milling Operation) Given a milling machine, selection of cutters, workpiece, detail drawing or blueprint, milling specifications, assortment or arbors, collars, and necessary hand tools, measuring instruments, and materials; perform side milling operation to a tolerance of +/- 0.001 inch of specifications, finishing work without gouges or marks.

9.10 (Perform Angular Milling Operation) Given milling machine, workpiece, cutters and attachments, work holding device, measuring instruments, detail drawing or blueprint, milling specifications, and the necessary hand tools and materials; perform angular mill operations to a tolerance of +/- 5 minutes and finish the workpiece without gouges or marks.

9.11 (Perform End Milling Operation) Given a milling machine, assortment of cutters, arbors, collars, and the necessary tools, equipment, measuring instruments, and materials; perform an end milling machine operation to bring surfaces to specifications to a tolerance of +/- 0.001 inches with finish smooth without gouges or marks.

9.12 (Drill, Bore, and Ream Holes) Given a milling machine, rectangular stock, detail drawing, drill and reaming specifications, and assortment of drill bits, reamers, and holders, and the necessary hand tools, measuring instruments, and materials; using the milling machine drill, bore, and ream holes in the stock to specifications for location and diameter (+/- 0.0005 inch) and perpendicularity (+/- 1 degree).

9.13 (Perform Keyseating and T-Slot Milling Operation) Given milling machine, blueprint-drawing, specifications, and necessary tools and materials; machine a Woodruff keyway (seat) in the workpiece with a tolerance of +/- 0.005 inch to specifications (+/- 1/64 inch fraction dimensions).

9.14 (Cut Slots With Milling Machine [Slitting Operations]) Given milling machine, slitting cutter, attachments, workpiece, blueprint-drawing and specifications, and the necessary tools, measuring instruments, and materials; mill internal slot to a tolerance of $\frac{+\ 0.010\text{ inch}}{-\ 0.000\text{ inch}}$ or specifications.

ADVANCED MILL WORK
(SECOND YEAR)

9.15 (Perform Indexing Operations) Given milling machine, indexing or dividing head, rectangular or cylindrical stock, detail drawing that required equally-spaced slots milled in workpiece, milling specifications, assortment of milling cutters and holders, and the necessary hand tools, attachments, measuring instruments, and materials; mill slot to specifications +/- 0.002 inch for location and +/- 0.001 inch for width and depth.

9.16 (Perform Graduating and Marking Operations) Given milling machine, accessories, flat or cylindrical surface workpiece, drawing and specifications, and the necessary tools, measuring instrument, and materials; cut graduation marks to .001 inch with a tolerance of +/- 0.0001 inch.

9.17 (Identify Types of Gears and Their Functions) Given selection of gears and gear arrangements, select and identify each gear. Describe at least three uses of each gear to the instructor's standards.

9.18 (Calculate Pitch, Diameters, Working Depth and Clearances for Machining Gears) Given a gear drawing (e.g., spur), calculate all dimensions to a tolerance of +/- 0.001 inch.

9.19 (Mill a Gear Rack) Given the milling machine, drawing, specifications, workpiece, machine accessories and cutters, and necessary tools, measuring instruments, and materials; mill a gear rack to specifications, tolerance of "zero" to .002 inch.

9.20 (Machine a Spur Gear) Given a detail drawing, a pre-cut workpiece, hand tools, precision measuring instruments, and the necessary machine tools, accessories, attachments, and materials; machine a spur gear. The gear must meet the specifications of the drawing with a tolerance of +/- 0.002 inch for pitch diameter and dimensions.

UNIT 9.0 BASIC MILL WORK

TASK 9.01 INSPECT AND CLEAN A MILLING MACHINE

PERFORMANCE OBJECTIVE:

Provided with a milling machine (horizontal or vertical), operator's manual, cleaning materials, and the necessary instruction, hand tools, and equipment; inspect and clean the milling machine according to the manufacturer's (or instructor's) information. The milling machine and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.

PERFORMANCE ACTIONS:

9.0101 Review directions for inspection and cleaning the given milling machine.

9.0102 Assemble adjustable wrench, screwdriver, wiping cloth, brush, and oil.

9.0103 If machine has automatic oiling system, follow manufacturer's instructions or process as follows (if instructor approves actions for the machine).

9.0104 Check level of oil in each reservoir sight glass (Arbor support, Table and Saddle, Oil Flow Gage, Driving Chain and Motor, Filler Cup for Column, and Filler Cup for Knee).

9.0105 Clean area surrounding filler cup.

9.0106 As necessary, add clean oil of type recommended by manufacturer to raise oil to proper level on gage glass.

9.0107 Return filler cup and tighten it securely.

9.0108 Check operation of oil pumps, looking for a stream of oil in gage glass when pump is functioning, if machine is equipped with flow gage.

9.0109 Locate, clean, and fill oil holes and pockets which require hand oiling.

9.0110 Inspect oiler for damage signs. Report any malfunctioning signs to instructor.

PERFORMANCE ACTIONS (Con't.):

9.0111 Replace screw plugs removed in oiling process.

9.0112 Wipe off excess or dripped oil.

9.0113 Thoroughly clean and lubricate all flat and round sliding surfaces which are not automatically oiled.

9.0114 Clean and lubricate sliding surfaces on overarm before changing its position in column.

9.0115 Clean and oil all exposed screws, such as elevating screw for the knee, if not oiled automatically.

EXTENSION OF ACTIONS: (Optional)

9.0116 The following inspection and cleaning actions typically are accomplished periodically rather than daily.

9.0117 Check height of oil for motor bearings, adding oil to adjust the level properly.

9.0118 If applicable, lubricate driving chain or check oil supply if lubricated by spash system.

9.0119 Check condition of oil filters, if applicable. (Clean or replace this felt pad or screen if it is loaded with particles.)

9.0120 Remove drain plugs and drain oil from reservoirs when discoloration or thinning of lubricant indicates need for the action. (This action may be scheduled to occur at a period of time.)

9.0121 Clean out reservoir to remove all sediment which has accumulated and flush it out with an oil solvent such as gasoline or naphtha.

9.0122 Screw drain plug securaly in place.

9.0123 Refill reservoir with clean oil of the type recommended by the manufacturer (S.A.E. 30 might be substituted).

9.0124 Grease all ball bearings and points requiring grease.

UNIT 9.0 BASIC MILL WORK

TASK 9.01 INSPECT AND CLEAN A MILLING MACHINE (Con't.)

PERFORMANCE STANDARDS:

- Inspect and clean a milling machine according to the instructor's or manufacturer's standards so that the surrounding area is free of metal chips, excess lubricant, and cutting fluid, and foreign material.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Explain purpose of performing routine inspection and cleaning of a milling machine.
- Describe procedure for inspecting and cleaning a milling machine.
- Identify materials used to clean a milling machine.
- Explain necessary safety precautions.
- Identify parts and functions of typical milling machine(s):
  - Functions of the milling machine.
  - Column and knee type.
  - Adjustable spindle type.
  - Plain and unifersal machines.
  - Vertical and bed.
  - End and face milling.
  - Column.
  - Knee.
  - Table.
  - Spindle.
  - Overarm.
  - Coolants and cutting fluids.

UNIT 9.0 BASIC MILL WORK

TASK 9.02 IDENTIFY MILLING MACHINE WORK HOLDING DEVICES AND THEIR FUNCTIONS

PERFORMANCE OBJECTIVE:

Given a shop milling machine and work holding devices and proper instruction; accurately identify each device and describe the type of work for which the device is designed.

PERFORMANCE ACTIONS:

9.0201 Identify the following milling machines vises:
  a. Plain.
  b. Swivel.

9.0202 Identify fixtures.

9.0203 Describe importance of holding workpiece securely and accurately.

9.0204 Select the appropriate work holding device for a given job. (Student's selection should be acceptable to the instructor.)

9.0205 Demonstrate following skills acceptable to instructor:
  a. Clean and replace vise on bed.
  b. Align vise by sight.
  c. Fasten vise by sight.
  d. Place dial indicator attachment in mill spindle or magnetic tool holder.
  e. Fasten dial indicator to attachment.
  f. Identify fixed vise jaws.
  g. Secure clamp bolts.
  h. Recheck with indicator.

PERFORMANCE STANDARDS:

- Identify milling machine work holding devices and their functions and demonstrate how to mount a given holding devices on a given milling machine.
- Performance actions and performance must be accurate and meet the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify:
  - Milling machine and parts.
  - Work holding devices for given jobs.
  - Types of stock worked with milling machine in typical training.
  - Measuring tools.

UNIT	9.0	BASIC MILL WORK
TASK	9.03	ALIGN WORKPIECE MOUNTED ON MACHINE TABLE

PERFORMANCE OBJECTIVE:

Given milling machine, blueprint (drawing), workpiece, and measuring instruments; align workpiece on machine table to a tolerance of 0.001 inches total indicator run out.

PERFORMANCE ACTIONS:

9.0301 Clean out slots on milling machine table.

9.0302 Review blueprint, drawing, etc.:
  a. Note surface to be machined.
  b. Identify type of cutter required.

9.0303 Place workpiece on machine table:
  a. Center workpiece longitudinally on table.
  b. Locate workpiece according to machining operation.

9.0304 Select clamps, blocks, and bolts and clamp workpiece down lightly in rough position.

9.0305 Clamp indicator assembly on arbor.

9.0306 Adjust indicator contact point toward workpiece surface.

9.0307 Move table and workpiece next to indicator contact point.

9.0308 Move table longitudinally.

9.0309 Adjust workpiece to correctly line up with indicator.

9.0310 Move table and workpiece in contact with indicator contact point.

9.0311 Adjust table against indicator about 0.0101 inches.

9.0312 Move table longitudinally the length of the workpiece.

9.0313 Observe total movement of indicator at each end of workpiece.

UNIT 9.0 BASIS MILL WORK

TASK 9.03 ALIGN WORKPIECE MOUNTED ON MACHINE TABLE

PERFORMANCE ACTIONS (Con't.):

9.0314 Adjust workpiece:
- a. Adjust workpiece one half difference of end reading.
- b. Tap lightly with soft hammer.

9.0315 Check workpiece with indicator for runout.

9.0316 Repeat steps until workpiece is within tolerance.

PERFORMANCE STANDARDS:

- Align workpiece on milling machine table to a tolerance of 0.001 inches total indicator run out.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Use of dial indicator and holder.
- Use of straps, clamps, bolts, parallels, etc.

UNIT 9.0 BASIC MILL WORK

TASK 9.04 ALIGN MILL HEAD TO TABLE

PERFORMANCE OBJECTIVE:

Given the ram and turret milling machine and measuring instruments, align the head with the table to a tolerance of +/- 0.0005 inch.

PERFORMANCE STANDARDS:

9.0401 Adjust head to "zero" graduation in both directions.

9.0402 Clean table and center under spindle.

9.0403 Mount dial indicator on 90 degree extension rod held in spindle holder.

9.0404 Position indicator over front of table.

9.0405 Carefully lower spindle under indicator button touches table.

9.0406 Lower spindle until dial indicator registers about 1/2 revolution and set on "zero."

9.0407 Lock spindle.

9.0408 Carefully rotate spindle 180 degrees by hand (watch T-slots).

9.0409 Compare front and back readings.

9.0410 Loose locking nuts and adjust head (reading difference and lock).

9.0411 Recheck setting and make adjustments.

9.0412 Raise and rotate spindle 90 degrees.

9.0413 Repeat steps as necessary.

9.0414 Check readings in both directions.

9.0415 Adjust and check until table is aligned with spindle to required tolerance.

UNIT 9.0 BASIC MILL WORK

TASK 9.04 ALIGN MILL HEAD TO TABLE (Con't.)

PERFORMANCE STANDARDS:

- Align mill head to table to a tolerance of 0.0005 inch.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Ram and turret milling machine.
- Use of dial indicator.

UNIT 9.0 BASIC MILL WORK

TASK 9.05 ALIGN MILLING MACHINE ATTACHMENTS

PERFORMANCE OBJECTIVE:

Given milling machine with attachments, measuring instruments, hand tools and materials; align attachments to a tolerance of 0.001 inch run out at 4 inches.

PERFORMANCE ACTIONS:

9.0501 Replace draw bar with extended draw bar.

9.0502 Drop quill approximately 3 inches and lock.

9.0503 Insert 90 degree attachment driver in quill and tighten draw bar securely, aligning key with keyway.

9.0504 Position indicating surface parallel with table movement.

9.0505 Attach two housing clamp bolts.

9.0506 Attach magnetic base with dial indicator.

9.0507 Indicate 90 degree milling attachment for parallel alignment with table movement.

9.0508 Secure housing clamp bolts.

9.0509 Check for accuracy, repeating steps as needed.

PERFORMANCE STANDARDS:

- Align milling machine attachments provided with a tolerance of 0.001 inch run out at 4 inches.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Identify parts of milling machine.
- Identify 90 degree milling attachment.
- Identify extended draw bar.
- Explain the magnetic base and post.
- Describe use of dial indicator.

UNIT 9.0 BASIC MILL WORK

TASK 9.06 ALIGN MILLING MACHINE FIXTURES WITH INDICATOR

PERFORMANCE OBJECTIVE:

Given a milling vise, clamping bolts, wrench, dial indicator, mallet, and square; align and fixture on the milling machine tool to within +/- 0.001 inch total runout.

PERFORMANCE ACTIONS:

9.0601 Clean and place vise on bed.

9.0602 Align vise by sight.

9.0603 Fasten vise to bed with clamping bolts (don't tighten yet*).

9.0604 Locate dial indicator in mill spindle or magnetic toolholder.

9.0605 Indicate fixed vise jaw:

a. Perpendicular alignment use square against column before using dial indicator.
b. Use longitudinal feed or cross feed as required.

9.0606 Check vise jaw at end of jaw.

9.0607 Tap vise one-half difference of reading for correction.

9.0608 Repeat steps until vise aligned.

9.0609 *Tighten clamp bolts.

9.0610 Check with indicator.

PERFORMANCE STANDARDS:

- Align milling machine vise with dial indicator to within +/- 0.001 inch total run out.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 9.0 BASIC MILL WORK

TASK 9.07 CALCULATE CUTTING SPEEDS AND FEEDS FOR MILLING MACHINE WORK

PERFORMANCE OBJECTIVE:

Given a milling machine and accessories, workstock, work assignment, and necessary tools and materials; select proper cutter and attachment, calculate speed and feed, and install the cutter. Performance must conform to the Machinery's Handbook.

PERFORMANCE ACTIONS:

9.0701 Identify and classify workpiece to be machined.

9.0102 Select cutter to be used.

9.0103 Determine condition of milling machine.

9.0104 Determine depth of cut to be made.

9.0105 Establish material cutting speed.

9.0106 Determine speed setting for machine by using table (or handout) tables.

9.0107 Set speed according to operation manual.

9.0108 Select and set feed, repeating appropriate steps outlined above, using tables provided and operation manual.

PERFORMANCE STANDARDS:

- Calculate cutting speeds and feed for milling machine work, select proper cutter for given workpiece, and set up milling machine.
- Performance must be to the standards of Machinery's Handbook and the instructor.

SUGGESTED INSTRUCTION TIME: [illegible] Hours

UNIT 9.0 BASIC MILL WORK

TASK 9.07 CALCULATE CUTTING SPEEDS AND FEEDS FOR MILLING MACHINE WORK (Con't.)

RELATED TECHNICAL INFORMATION:

- Define cutting speed.
- Define cutting feed.
- Identify factors determining speed and feed.
- Describe tempered cutters.
- Describe carbide cutters.
- Describe high speed cutters.
- Correctly use the cutting speed formula.
- Describe/demonstrate how to take rough and finish cuts.

UNIT 9.0 BASIC MILL WORK

TASK 9.08 FACE MILL WORKPIECE

PERFORMANCE OBJECTIVE:

Given a milling machine with workpiece mounted in a jig, detail drawing or blueprint, facing specifications, an assortment or arbors, collars, and milling cutters, and the necessary hand tools, measuring instruments, and materials; face mill the workpiece to specifications to a tolerance of +/- 0.001 inch. Finished work must be smooth without gouges or marks.

PERFORMANCE ACTIONS:

9.0801 Set up milling machine.

9.0802 Select and mount cutter.

9.0803 Mount workpiece.

9.0804 Make cut.

PERFORMANCE STANDARDS:

- Face mill workpiece to specifications to a tolerance of +/- 0.001 inch with no gouges or marks in finished workpiece.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Identify milling cutters used for face milling operations.
- Explain how to mount a face milling cutter in the spindle.
- Define a face milling operation.
- Calculate cutting speed, feed, and depth of cut for face milling operation.
- Explain right-hand and left-hand face milling cutters.
- Describe how to mount a cutter:
  a. Stub arbor.
  b. Bolted to spindle.
- Explain how to surface finish a face milled workpiece.
- Identify safety considerations.

UNIT 9.0 BASIC MILL WORK

TASK 9.09 PERFORM SIDE MILLING OPERATION

PERFORMANCE OBJECTIVE:

Given a milling machine, selection of cutters, workpiece, detail drawing or blueprint, milling specifications, assortment of arbors, collars, and necessary hand tools, measuring instruments, and materials; perform side milling operation to a tolerance of +/- 0.001 inch of specifications, finishing work without gouges or marks.

PERFORMANCE ACTIONS:

9.0901 Set up machine for side milling operation.

9.0902 Select and mount cutter.

9.0903 Mount workpiece.

9.0904 Make required cut to specifications.

PERFORMANCE STANDARDS:

- Perform side milling operation to a tolerance of +/- 0.001 inch to specifications, finishing work without gouges or marks.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Describe side milling.
- Select side milling cutters.
- Determine speeds and feeds.
- Select attachments for side milling.
- Select holding devices for side milling.
- Align work on milling machine.

UNIT 9.0 BASIC MILL WORK

TASK 9.10 PERFORM ANGULAR MILLING OPERATION

PERFORMANCE OBJECTIVE:

Given milling machine, workpiece, cutters and attachments, work holding device, measuring instruments, detail drawing or blueprint, milling specifications, and the necessary hand tools and materials; perform angular mill operations to a tolerance of +/- 5 minutes and finish the workpiece without gouges or marks.

PERFORMANCE ACTIONS:

9.1001 Identify and classify workpiece (material).

9.1002 Mount and align angle plate.

9.1003 Select and mount end mill cutter.

9.1004 Select and set speed, feed, and depth of cut.

9.1005 Make cut.

9.1006 Check surface and tolerance specifications, making machine adjustments as necessary.

9.1007 Measure and inspect workpiece.

PERFORMANCE STANDARDS:

- Perform angular milling operation to a tolerance of +/- 5 minutes and finish workpiece without gouges or marks.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Explain an angular milling operation.
- Identify angular milling cutters.
- Calculate speeds and feeds.
- Select attachments for angular milling operation.
- Select work holding devices.
- Align work for angular milling operation.

UNIT 9.0 BASIC MILL WORK

TASK 9.10 PERFORM ANGULAR MILLING OPERATION (Con't.)

EXPANSION OF TASK:

1. MILL CHAMFER (Optional)

Given chamfering specifications, assortment of angular arbors, collets, and angular cutters, milling machine, workpiece mounted in a universal vise, detail drawing, and necessary tools, measuring instruments, and materials; mill chamfer to specifications +/- .005 inch.

2. MILL BEVEL

Given milling machine, workpiece mounted in universal vise, detail drawing, bevel specifications, assortment or arbors, collars, and angular cutters, and the necessary hand tools, measuring instruments, and materials; mill the bevel to specifications +/- .005 inch.

UNIT 9.0 BASIC MILL WORK

TASK 9.11 PERFORM END MILLING OPERATION

PERFORMANCE OBJECTIVE:

Given a milling machine, assortment of cutters, arbors, collars, and the necessary tools, equipment, measuring instruments, and materials; perform an end milling machine operation to bring surfaces to specifications to a tolerance of +/- 0.001 inch with finish smooth without gouges or marks.

PERFORMANCE ACTIONS:

9.1101 Identify and classify workpiece (material).

9.1102 Mount and align vise.

9.1103 Secure workpiece in holding device.

9.1104 Select and mount end mill cutter.

9.1105 Select and set speed and feed.

9.1106 Align workpiece, touch off, and set depth of cut.

PERFORMANCE STANDARDS:

- Perform end milling operation to bring surfaces to specifications +/- 0.001 inch with a smooth finish without gouges or marks.

SUGGESTED INSTRUCTION TIME: 21 Hours

RELATED TECHNICAL INFORMATION:

- Describe an end milling operation.
- Identify end milling cutters.
- Calculate speeds and feeds.
- Identify attachments.
- Identify holding devices.
- Describe/demonstrate work alignment.
- Identify safety considerations.

UNIT 9.0 BASIC MILL WORK

TASK 9.12 (Multiple Tasks) DRILL, BORE, AND REAM HOLES

PERFORMANCE OBJECTIVE:

Given a milling machine, rectangular stock, detail drawing, drill and reaming specifications, an assortment of drill bits, reamers, and holders, and the necessary hand tools, measuring instruments, and materials; using the milling machine drill, bore, and ream holes in the stock to specifications for location and diameter (+/- 0.0005 inch) and perpendicularity (+/- 1 degree).

PERFORMANCE ACTIONS:

9.1201 DRILLING:

(1) Mount and align holding device.
(2) Secure part in holding device.
(3) True in over first hole to be drilled.
(4) Set machine speed.
(5) Center-drill workpiece.
(6) Drill first hole.
(7) Use mill graduated dials to step over and drill subsequent holes to specifications.
(8) Check work.

9.1202 BORING:

(1) Layout hole location.
(2) Secure workpiece to table.
(3) True mill wiggler.
(4) Locate center of hole.
(5) Select and set speeds and feeds as necessary.
(6) Countersink workpiece.
(7) Drill pilot hole.
(8) Drill hole to allow for clearance in boring.
(9) Bore hole to dimensions.

9.1203 REAMING:

(1) Identify and classify workpiece material.
(2) Mount and align holding device.
(3) Secure and align workpiece.
(4) Select and set speed and feed as necessary.
(5) Center-drill workpiece.
(6) Drill workpiece to specifications.
(7) Ream hole to specifications.

PERFORMANCE STANDARDS:

- Drill, bore, and ream holes in given workpiece to specifications, centered and finished to a tolerance of +/- 0.0005 inch.

SUGGESTED INSTRUCTION TIME: 12 Hours

RELATED TECHNICAL INFORMATION:

- DRILLING AND REAMING ON MILL
  - Identify methods for holding workpieces for drill and reaming.
  - Describe how to layout and drill equally-spaced holes.
  - Describe procedure for drilling and reaming holes.
  - Explain use of cutting fluid in drilling and reaming.
  - Calculate cutting feeds and speeds for drilling and reaming.
- BORING ON MILL
  - Describe/demonstrate how to adjust boring head.
  - Calculate cutting speed and feed for boring operation.
  - Explain setup requirements for boring operation.
  - Describe procedure for boring holes with milling machine.
  - Explain use of cutting fluid.
- Explain how to obtain accuracy.
- Identify safety considerations.
- Explain how to determine hole sizes.

UNIT 9.0 BASIC MILL WORK

TASK 9.13 PERFORM KEYSEATING AND T-SLOT MILLING OPERATION

PERFORMANCE OBJECTIVE:

Given milling machine, blueprint-drawing, specifications, workpiece and precision measuring instruments, and necessary tools and materials; machine a Woodruff keyway (seat) in the workpiece with a tolerance of +/- 0.005 inch to specifications (+/- 1/64 inch fraction dimensions).

PERFORMANCE ACTIONS:

9.1301 KEY SEATING:

(1) Mount, secure, and align vise to table.
(2) Select, mount, and secure cutter (Woodruff key seat).
(3) Set machine speed.
(4) Set center line of cutter on center line of shaft, close to holding device.
(5) Turn machine on and touch off.
(6) Mill to prescribed depth and length.

(See V-TECS Machinist Task 163 for more detailed actions.)
(See Milling Machine Work, Albany, NY: Delmar Publishers, Inc., pp. 214-216, 1953, for standards.)

9.1302 T-SLOTTING: (Task Expansion)

(1) Identify and classify workpiece.
(2) Secure workpiece to table.
(3) Position slotting attachment over table.
(4) Select and secure cutter to spindle.
(5) Select and adjust stroke length.
(6) Align cutter to workpiece.
(7) Set speed.
(8) Slot to specifications.

PERFORMANCE STANDARDS:

- Machine a Woodruff keyway (seat) in given workpiece to specifications +/- 0.005 inch.

UNIT 9.0 BASIC MILL WORK

TASK 9.13 PERFORM KEYSEATING AND T-SLOT MILLING OPERATION (Con't.)

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Identify accuracy required.
- Identify machine attachments, holding devices, and cutters.
- Describe/demonstrate work alignment.
- Decide on speeds and feeds.
- Determine slot and seat sizes.
- Demonstrate how to set up machine.
- Demonstrate selection and mounting of cutters.
- Demonstrate how to make a cut.
- *Machinery's Handbook*.
- Identify safety considerations.

UNIT 9.0 BASIC MILL WORK

TASK 9.14 CUT SLOTS WITH MILLING MACHINE (Slitting Operation)

PERFORMANCE OBJECTIVE:

Given milling machine, slitting cutter, attachments, workpiece, blueprint-drawing and specifications, and the necessary tools, measuring instruments, and materials; mill internal slot to a tolerance of $\frac{+\ 0.010\ \text{inch}}{-\ 0.000\ \text{inch}}$ or specifications.

PERFORMANCE ACTIONS:

9.1401 Set up mill: Select and mount cutter.

9.1402 Mount and align workpiece.

9.1403 Select and set speed, feed, and depth of cut.

(See: Milling Machine Work, Albany, NY: Delmar Publishers Inc., pp. 192-194, 109-120 for possible enabling objectives, 1953.)

9.1404 Align workpiece to cutter.

9.1405 Mill workpiece.

9.1406 Measure finished part for accuracy.

PERFORMANCE STANDARDS:

- Cut slots with milling machine to specifications within 0.010 inch.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Describe what accuracy is required.
- Identify attachment.
- Identify holding devices.
- Select and mount slitting cutter.
- Describe gang slitting.
- Align work.
- Determine depth of cut and length of feed.
- Describe how to measure finished part.

ADVANCED MILL WORK

The following tasks, 9.15 - 9.20, which represent Advanced Mill Work typically will be introduced during the second year of training. The instructional time represented by these task objectives has been included in the second year plan for the secondary level Machine Shop program. For the purpose of organization and to represent the typical order of learning development, basic and advanced mill work objectives are not separated.

The second year description of Machine Shop will include a "comment" to identify that Advanced Mill Work training is included in the second year "instructional time plan" and to refer the student, instructor, or others to the second year tasks described in Unit 9.

UNIT 9.0 ADVANCED MILL WORK

TASK 9.15 PERFORM INDEXING OPERATIONS

PERFORMANCE OBJECTIVE:

Given milling machine, indexing or dividing head, rectangular or cylindrical stock, detail drawing that required equally-spaced slots milled in workpiece, milling specifications, assortment of milling cutters and holders, and the necessary hand tools, attachments, measuring instruments, and materials; mill slots to specifications +/- 0.002 inch for location and +/- 0.001 inch for width and depth.

PERFORMANCE ACTIONS:

9.1501 Identify and classify workpiece material.

9.1502 Mount and align dividing head.

9.1503 Select and mount cutter.

9.1504 Mount and align holding device and workpiece.

9.1505 Determine number of indexes that workpiece must be rotated.

9.1506 Set up indexing unit of dividing head.

9.1507 Select and set up speed and feed.

9.1508 Touch off, make primary cut, and adjust depth of cut.

9.1509 Measure for blueprint specifications, making necessary adjustments.

9.1510 Recut if necessary.

9.1511 Rotate indexing unit for each subsequent cut specified.

9.1512 Inspect and measure finished part to specifications.

PERFORMANCE STANDARDS: (NOTE: Specifications divided in direct and simple indexing operations.)

PERFORMANCE STANDARDS (Con't.):

- DIRECT INDEXING
  - Mill slots by direct indexing to specifications with a tolerance of +/- 0.002 inch for location and +/- 0.001 inch for width and depth.
  - Disengage worm and turn indexing plate with spindle attached by hand.
- SIMPLE INDEXING
  - Mill workpiece by simple indexing to specifications with a tolerance of +.- 1/2 degree for location of cuts and +/- 0.002 inch for all dimensions.
  - Correctly use 1:40 ratio in advancing worm.
  - Correctly use formula for the number of turns of the crank for indexing.

SUGGESTED INSTRUCTION TIME: 20 Hours

RELATED TECHNICAL INFORMATION:

- Define: Indexing, direct indexing, simple indexing, and angular indexing.
- Explain the construction of an indexing or dividing head.
- Explain the operation of an indexing or dividing head.
- Explain difference between simple and direct indexing: Advantages and disadvantages
- Explain setup requirements for milling slots by direct indexing.
- Describe procedure for milling slots by direct indexing.
- Calculate cutting feed, speed, and depth of cut for milling slots by direct indexing.
- Identify applications using the indexing head with tailstock or chuck.
- Explain how to operate dividing head for simple indexing.
- Identify applications for using simple indexing to machine workpiece on a mill.
- Explain setup requirements for milling a workpiece by simple indexing.
- Describe procedures for milling workpiece by simple indexing.
- Calculate cutting speed and feed for a simple indexing operation.
- Calculate "crank turns" for a simple indexing operation.
- Describe work and vise alignment.
- Explain accuracy required.
- Identify attachments and cutters.
- Identify safety considerations.

EXPANSION OF TASK: (Optional)

DRILL HOLES BY ANGULAR INDEXING

PERFORMANCE OBJECTIVE:

Given horizontal milling machine, dividing or indexing head, pre-cut cylindrical stock, detail drawing that requires holes to be drilled in workpiece at specified angles, hole specifications, assortment of twist drills and holders, and the necessary hand tools, measuring instruments, and materials; drill the holes in the stock using angular indexing to specifications with a tolerance of +/- 15 minutes for location.

PERFORMANCE ACTIONS: (To be clarified by instructor.)

PERFORMANCE STANDARDS: (See objective.)

RELATED TECHNICAL INFORMATION:

- Explain calculations required to perform angular indexing.
- Calculate cutting speed and feed for angular indexing operation.
- Explain setup requirements for drilling holes using angular indexing method.
- Describe procedure for drilling holes by angular indexing.
- Explain differences among direct, simple, and angular indexing.
- Identify safety considerations.

UNIT 9.0 ADVANCED MILL WORK

TASK 9.16 PERFORM GRADUATING AND MARKING OPERATIONS

PERFORMANCE OBJECTIVE:

Given milling machine, accessories, flat or cylindrical surface workpiece, drawing and specifications, and the necessary tools, measuring instrument, and materials; cut graduation marks to .001 inch with a tolerance of +/- 0.0001 inch.

PERFORMANCE ACTIONS:

9.1601 Set up machine.

9.1602 Select and mount cutters.

9.1603 Cut graduation marks according to standard procedures.

9.1604 Measure for tolerance.

PERFORMANCE STANDARDS:

- Cut graduation marks to .001 inch with a tolerance of +/- 0.0001 inch on flat or cylindrical surface workpiece.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Describe accuracy required.
- Identify attachments, scriber, tool and arbor, and spacers.
- Select speeds and feeds.
- Determine graduation degrees.
- Describe how to select holding devices.
- Describe how to align work.
- Describe use of index head and gear train for cylindrical work, if applicable.
- Machinery's Handbook.

UNIT 9.0 ADVANCED MILL WORK

TASK 9.17 IDENTIFY TYPES OF GEARS AND THEIR FUNCTIONS

PERFORMANCE OBJECTIVE:

Given selection of gears and gear arrangements, select and identify each gear. Describe at least three uses of each gear to the instructor's standards.

PERFORMANCE ACTIONS:

9.1701 Select, identify, and describe functions of given gears.

9.1702 Identify method of manufacturing (milling) given gears.

PERFORMANCE STANDARDS:

- Identify types of gears and their functions and typical methods of milling gears.
- Instructor's standards apply.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Identify:
  - Spur gears
  - Worm gears
  - Rack and pinion gears
  - Hypoid gears
  - Bevel gears
  - Herringbone gears
  - Helical gears
  - Planetary sets
  - Gear ratios
- Describe materials used in gear manufacturing.

EXPANSION OF TASK: (3 Hours)

- Given gear drawing, label each part (name gear tooth elements on different gears) using correct symbol with 100 percent accuracy.

EXPANSION OF TASK (Con't.):

- Identify:
  - Face
  - Flank
  - Pitch circle
  - Root circle
  - Addendum
  - Dedendum
  - Circular pitch
  - Working depth
  - Clearances
  - Chordal thickness
  - Pitch and outside diameters
  - Pressure angle
  - Tooth profile

UNIT	9.0	ADVANCED MILL WORK
TASK	9.18	CALCULATE PITCH, DIAMETERS, WORKING DEPTH AND CLEARANCES FOR MACHINING GEARS

PERFORMANCE OBJECTIVE:

Given a gear drawing (e.g., spur), calculate all dimensions to a tolerance of +/- 0.001 inch.

PERFORMANCE ACTIONS:

9.1801 Using references and procedures outlined by instructor, determine dimensions for given gear with diametral pitch and pressure angle known.

9.1802 If required, expand task to make gear to specifications.

PERFORMANCE STANDARDS:

- Calculate pitch, diameters, working depth and clearances for machining gears with a tolerance of +/- 0.001 inch.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Use formulas:
  - Pitch diameter
  - Diametral pitch
  - Addendum
  - Dedendum
  - Outside diameter
  - Number of teeth
  - Tooth thickness
  - Whole depth
  - Clearance
  - Center distance
  - Center distance
  - Working depth
  - Chordal tooth thickness
  - Chordal addendum
  - Center distance
- Explain pressure angles.
- Machinery's Handbook.

UNIT	9.0	ADVANCED MILL WORK
TASK	9.19	MILL A GEAR RACK

PERFORMANCE OBJECTIVE:

Given the milling machine, drawing, specifications, workpiece, machine accessories and cutters, and necessary tools, measuring instruments, and materials; mill a gear rack to specifications, tolerance of "zero" to .002 inch.

PERFORMANCE ACTIONS: (See Task 170, V-TECS Catalog Machinist)

9.1901 Mount dividing head and tailstock.

9.1902 Secure mandrel to indexing head.

9.1903 Select and secure cutter to mill.

9.1904 Determine and set indexing head to correct division.

9.1905 Center gear blank to cutter.

9.1906 Select and set speed, feed, and depth of cut.

9.1907 Cut gear to specifications.

PERFORMANCE STANDARDS:

- Mill gear rack to specifications with a tolerance of "zero" to .002 inch.

SUGGESTED INSTRUCTION TIME: 12 Hours

RELATED TECHNICAL INFORMATION:

- Identify machine attachments.
- Explain index head.
- Calculate, cutting feeds, speeds.
- Describe/demonstrate job setup.
- Explain rack milling attachment.
- Calculate dimensions for circular pitch and whole depth.
- Select gear tooth cutters.
- Demonstrate making trial cuts.
- Machinery's Handbook.

UNIT 9.0 ADVANCED MILL WORK

TASK 9.20 MACHINE A SPUR GEAR

PERFORMANCE OBJECTIVE:

Given a detail drawing, a pre-cut workpiece, hand tools, precision measuring instruments, and the necessary machine tools, accessories, attachments, and materials; machine a spur gear. The gear must meet the specifications of the drawing with a tolerance of +/- 0.002 inch for pitch diameter and dimensions.

PERFORMANCE ACTIONS:

9.2001 Set up milling machine.

9.2002 Press gear blank on mandrel.

9.2003 Mount dividing head and tailstock on mill.

9.2004 Secure mandrel to indexing head.

9.2005 Select and secure cutter to mill.

9.2006 Determine and set indexing head to correct divisions.

9.2007 Center gear blank to cutter.

9.2008 Select and set speed, feed, and depth of cut.

9.2009 Cut gear to specifications.

PERFORMANCE STANDARDS:

- Machine a spur gear to specifications of the drawing with a tolerance of +/- 0.002 inch for pitch diameter and dimensions.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify machine tools necessary to machine a spur gear.
- Identify spur, bevel and miter, internal, helical, and work gears and explain their applications.
- Identify parts of a spur gear.
- Identify tool and cutters used to machine a spur gear.

RELATED TECHNICAL INFORMATION (Con't.):

- Describe procedures for machining a spur gear.
- Identify setup requirements for machining a spur gear.
- Calculate cutting speeds and feed used for each machining operation.
- Explain gear blanks.
- Calculate dimensions.
- Select gear tooth cutters.
- Describe how to make trial cuts.
- Machinery's Handbook.

LEARNING PROJECTS
FIRST YEAR

Secondary machine shop instructors mutually agree concerning the advantages of using learning projects to help students gain knowledge and skills in basic machining. Learning projects are employed during the first year and second year of the Machine Shop programs at the four career centers.

Learning projects may include jobs for other vocational programs, the School District, students, or faculty.

Projects might include the machining of fasteners, tools, and other items for vocational programs as Automotive Mechanics, Air Conditioning-Refrigeration-Heating, and Electricity. Projects for vocational programs have included machining tools from drawings, repairing tools and equipment and parts, as well as designing and producing parts such as plastic molded electrical jacks used in electrical training.

Projects for the School District are varied, but include such jobs as machining keyways, gears, etc., to assist the maintenance department.

Projects for students or faculty may be included if the job tasks contribute to training objectives.

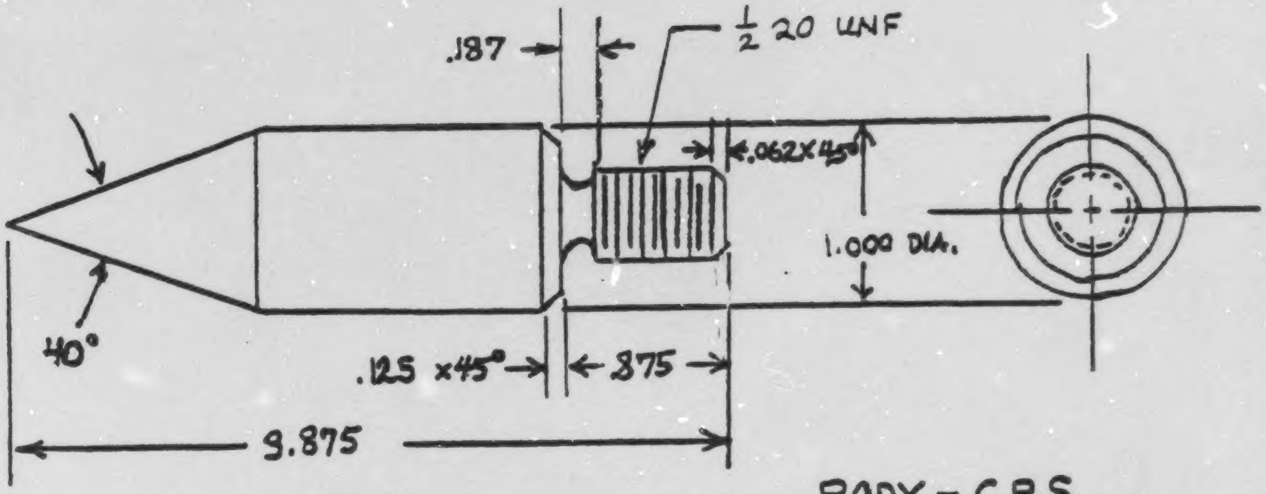
Typical first year machine shop projects may include machining the following products.

- Five types of hammers including the Ball Peen, Mallet, Rivetting, and meat tenderizer.
- Plumb Bob
- Center Holder
- Bench Block
- Lathe Dog
- Parallel Clamps
- Gear Puller
- Center Finder
- Flycutter
- Boring Bar
- Adjustable Square

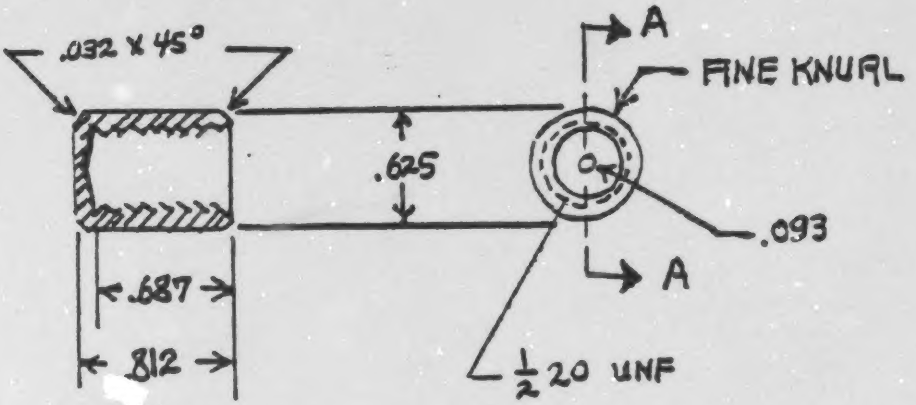
It is recommended that each machine shop project include a written description of the training objective, the key steps to accomplish the objectives, the minimum acceptable performance standards, and a suggested time in which to accomplish the objective.

It is suggested that the description of the second year learning projects (Unit 19) be reviewed after reading this description of first year learning projects.

INSTRUCTION TIME PLANNED FOR FIRST YEAR LEARNING PROJECTS: 82 Hours


.187
½ 20 UNF
.062X45°
1.000 DIA.
40°
.125 x45°
.875
3.875

BODY - C.R.S.


.032 X 45°
A
FINE KNURL
.625
.093
A
.687
.812
½ 20 UNF

SECTION A - A

CAP - ALUM

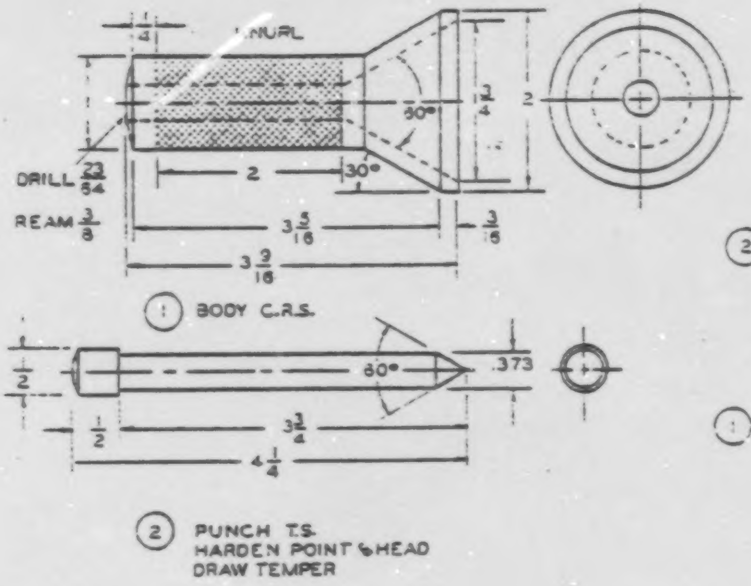
BEST COPY AVAILABLE

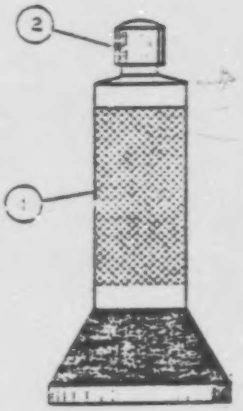
PLUMB BOB

349-A SCALE FULL ~ MATL. AS NOTED

TOL. ±.010 / ANG ±30' / H.T. TR. NONE

Bell center punch


1/4
KNURL
60°
30°
2
1 3/4
2
DRILL 23/64
REAM 3/8
3 5/16
3/16
3 9/16
① BODY C.R.S.
1/2
60°
.373
1/2
3 3/4
4 1/4
② PUNCH T.S.
HARDEN POINT & HEAD
DRAW TEMPER



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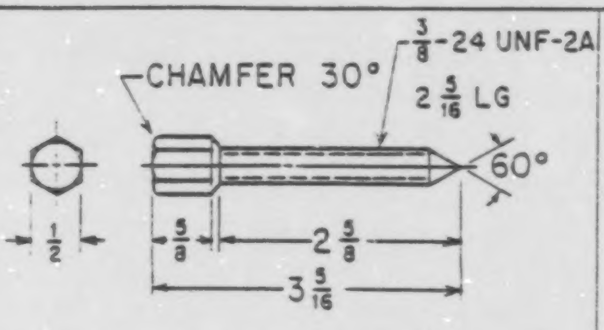
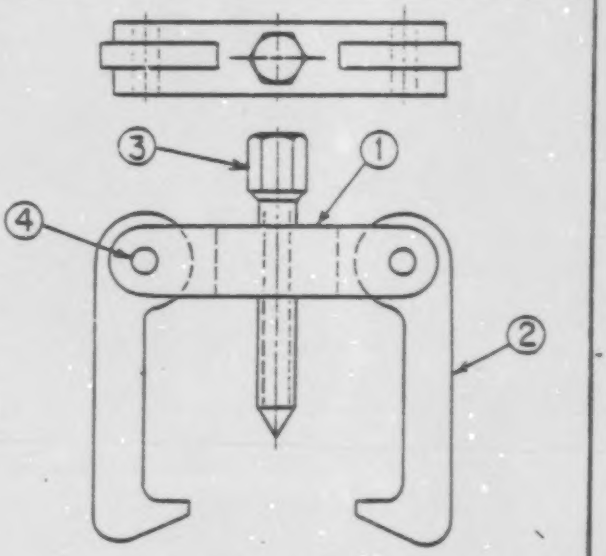
Wheel Puller


CHAMFER 30°
3/8-24 UNF-2A
2 5/16 LG
60°
1/2
5/8
2 5/8
3 5/16

③ SCREW-1 REQ'D-CASE HARDEN



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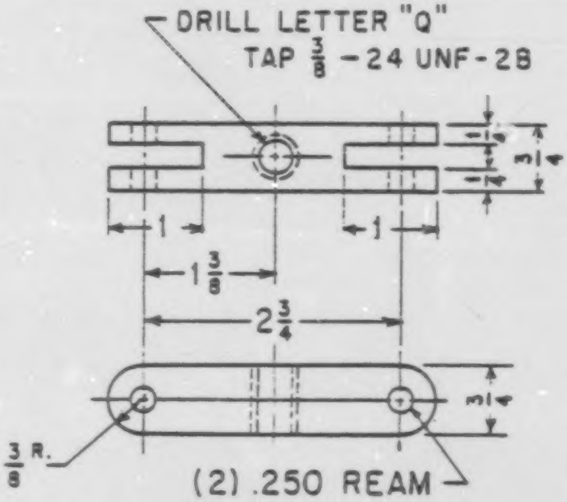
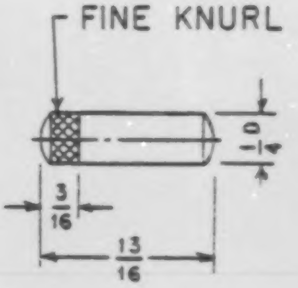
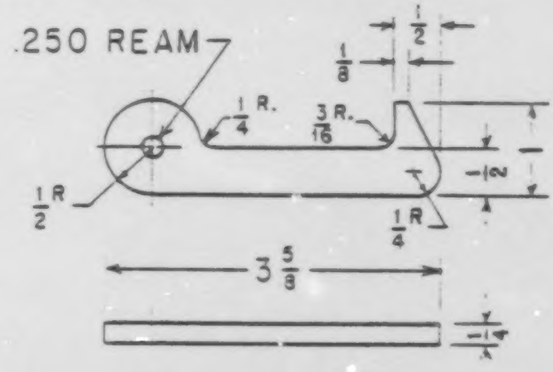

DRILL LETTER "Q"
TAP 3/8 -24 UNF-2B
1/4
3/4
1/4
1
1
1 3/8
2 3/4
3/4
3/8 R.
(2) .250 REAM

① CROSS BAR - 1 REQ'D


FINE KNURL
1/4 D
3/16
13/16

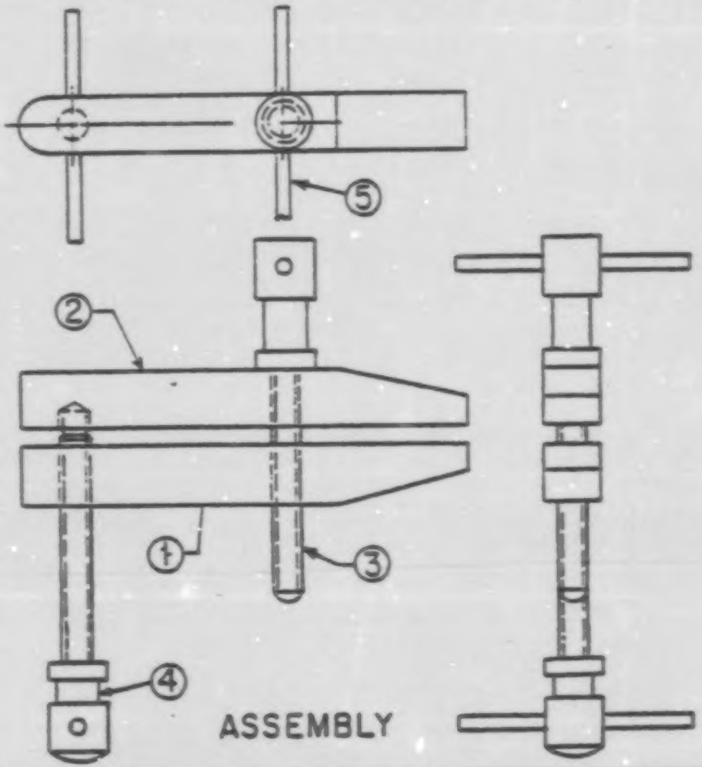
④ PIN - 2 REQ'D 2 x SIZE


.250 REAM
1/2
1/8
1/4 R.
3/16 R.
1/2
1/2 R
1/4 R
3 5/8
1/4

② JAW - 2 REQ'D

4	PIN	2	ST
3	SCREW	1	ST
2	JAW	2	ST
1	CROSS BAR	1	ST
No.	NAME	REQ.	MAT.

Machinist's Clamp



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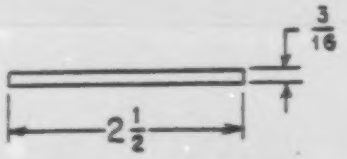
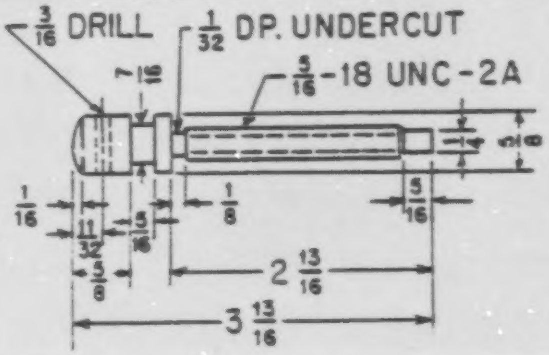
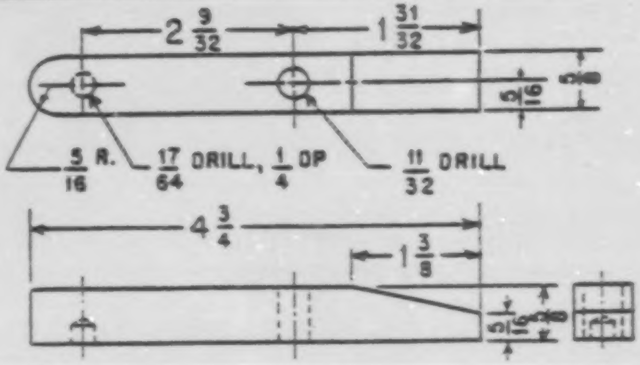


⑤ PIN



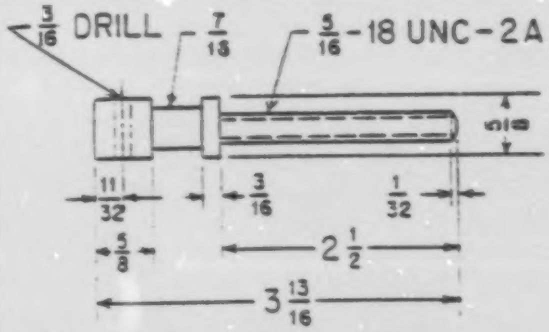
3/16 DRILL
1/32 DP. UNDERCUT
7/16
5/16-18 UNC-2A
1/4
5/8
1/16
11/32
5/16
1/8
5/16
5/8
2 13/16
3 13/16

④ PILOT SCREW



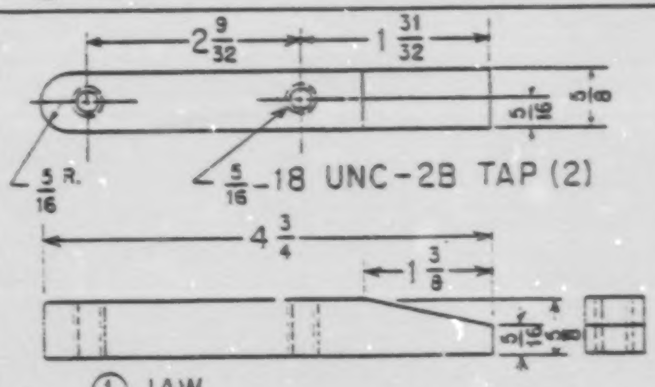
2 9/32
1 31/32
5/16
5/8
5/16 R.
17/64 DRILL, 1/4 DP
11/32 DRILL
4 3/4
1 3/8
5/16
5/8

② JAW



3/16 DRILL
7/16
5/16-18 UNC-2A
5/8
11/32
3/16
1/32
5/8
2 1/2
3 13/16

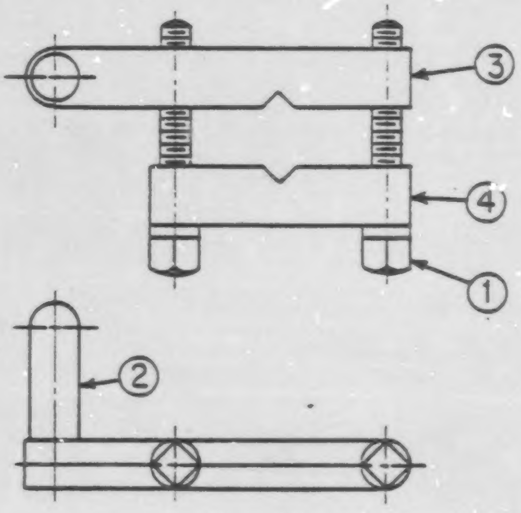
③ SCREW



2 9/32
1 31/32
5/16
5/8
5/16 R.
5/16-18 UNC-2B TAP (2)
4 3/4
1 3/8
5/16
5/8

① JAW

Lathe Clamp



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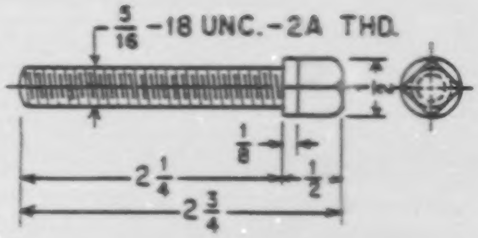
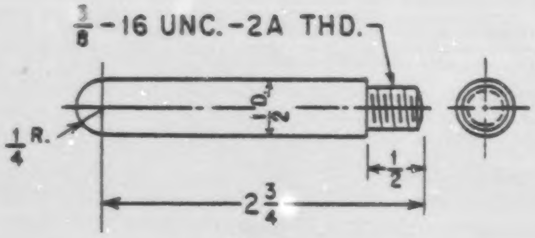
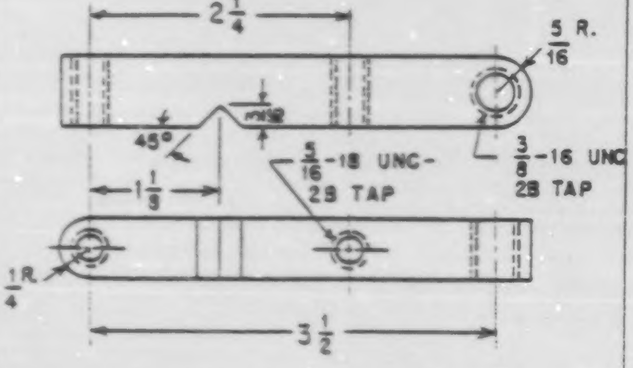

5/16 -18 UNC.-2A THD.
1/2
1/8
2 1/4
1/2
2 3/4

① SCREW

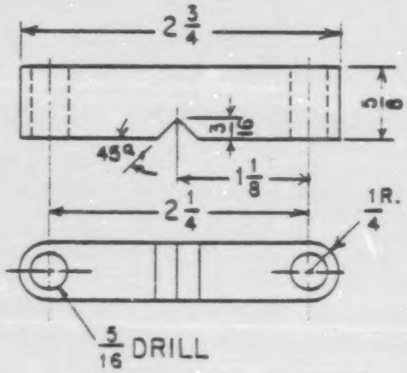
NOTE: ALL MATERIAL IS C.R.S.


3/8 -16 UNC.-2A THD.
1/4 R.
1/2
1/2
2 3/4

② LUG

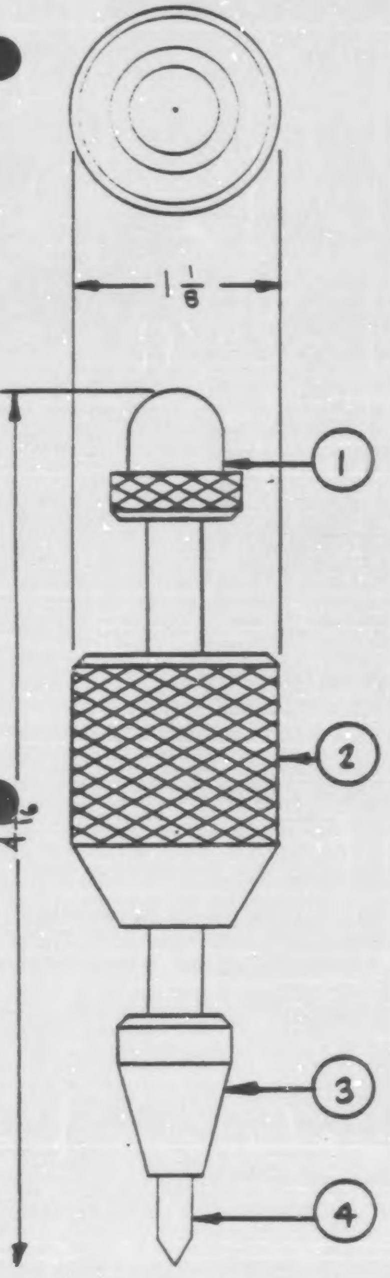

2 1/4
5/16 R.
3/32
45°
3/8 -16 UNC
2B TAP
5/16 -18 UNC-
2B TAP
1 1/8
1/4 R.
3 1/2

③ DRIVE CLAMP

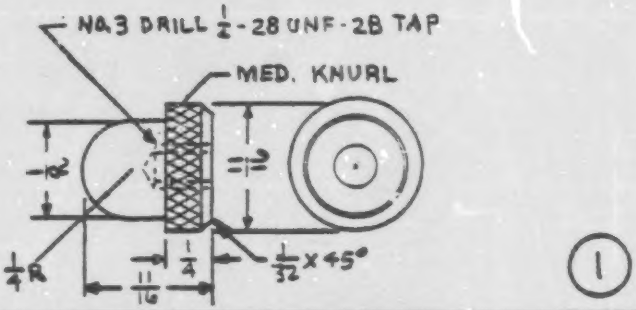

2 3/4
5/8
3/16
45°
1 1/8
2 1/4
1/4 R.
5/16 DRILL

④ HOLDING CLAMP

ASSEMBLY


1 1/8
4 1/16
1
2
3
4

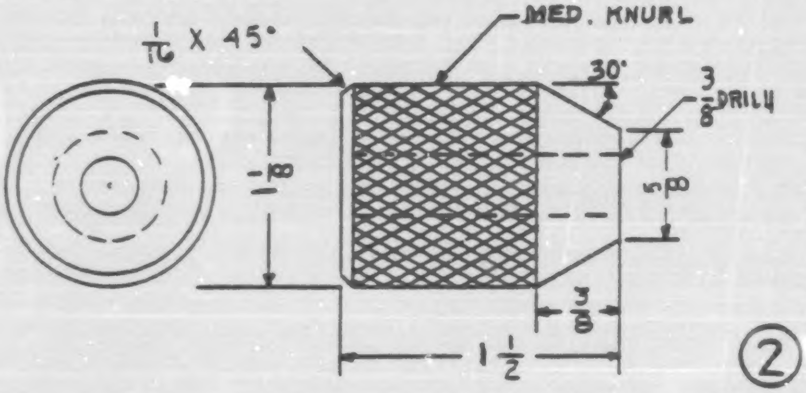
CAP


NO.3 DRILL 1/2-28 UNF-2B TAP
MED. KNURL
1/2
11/16
1/4 R
11/16
1/4
1/32 X 45°
1

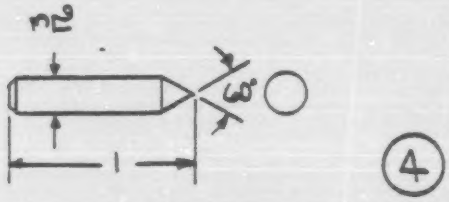
PARTS LIST

NO.	NAME	MAT.	REQ
1	CAP	STEEL	1
2	WEIGHT	STEEL	1
3	SHANK	STEEL	1
4	POINT	STEEL	1

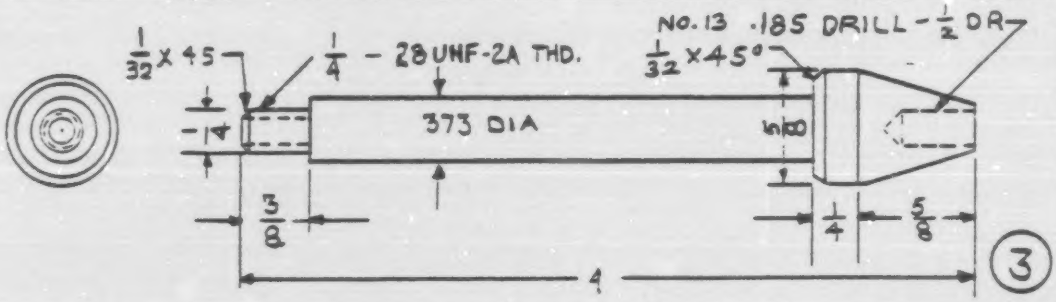
WEIGHT

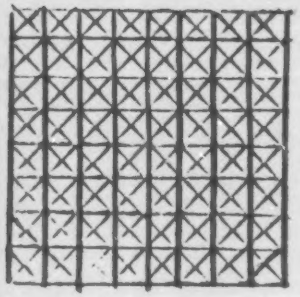

MED. KNURL
1/16 X 45°
30°
3/8 DRILL
1 1/8
5/8
3/8
1 1/2
2

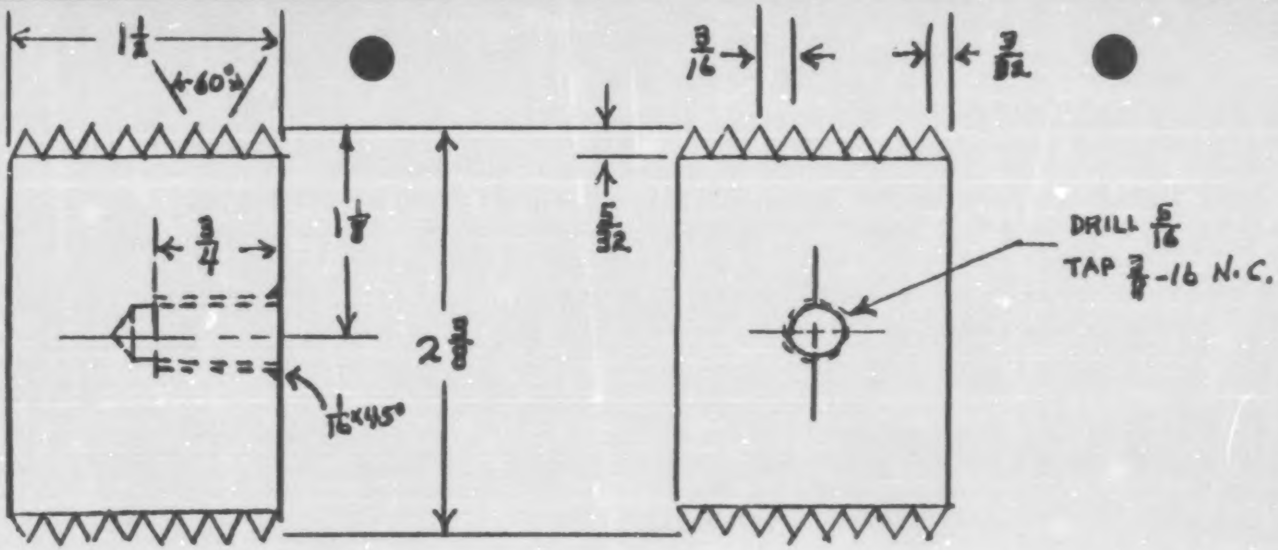
POINT



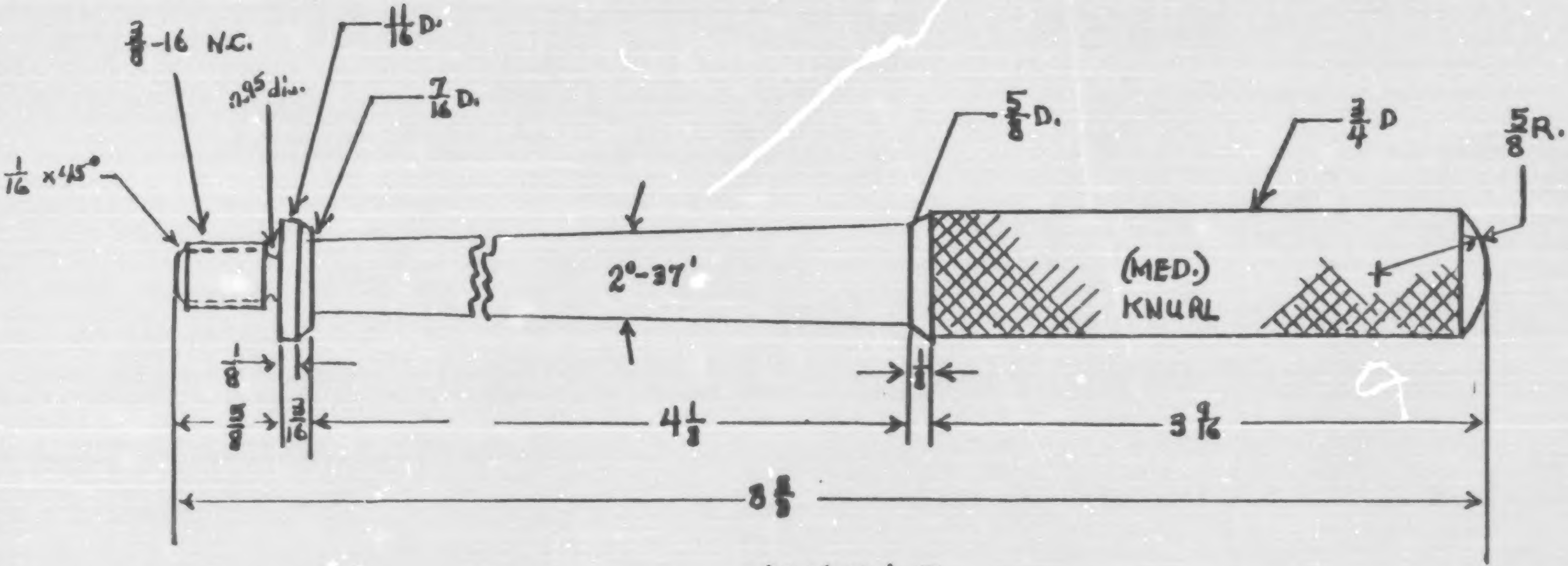
SHANK


1/32 X 45
1/4 - 28 UNF-2A THD.
NO. 13 .185 DRILL - 1/2 DR
1/32 X 45°
1/4
373 DIA
3/8
3/8
1/4
5/8
4
3


TOP VIEW OF HEAD


1 1/2
60°
3/16
3/32
1 1/8
5/32
3/4
2 3/8
1/16 x 45°
DRILL 5/16
TAP 3/8-16 N.C.

HEAD MATERIAL: ALUMINUM


3/8-16 N.C.
.295 dia.
11/16 D.
7/16 D.
1/16 x 45°
2°-37'
5/8 D.
3/4 D
5/8 R.
(MED.) KNURL
1/8
5/8
3/16
4 1/8
1/8
3 9/16
8 5/8

HANDLE MATERIAL: ALUMINUM

349-G

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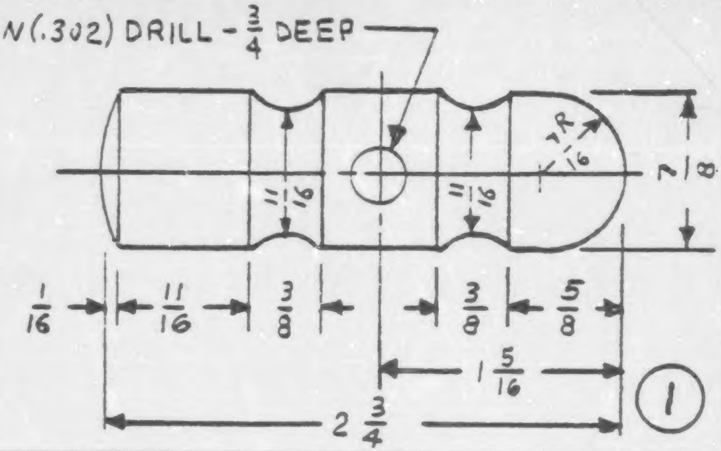
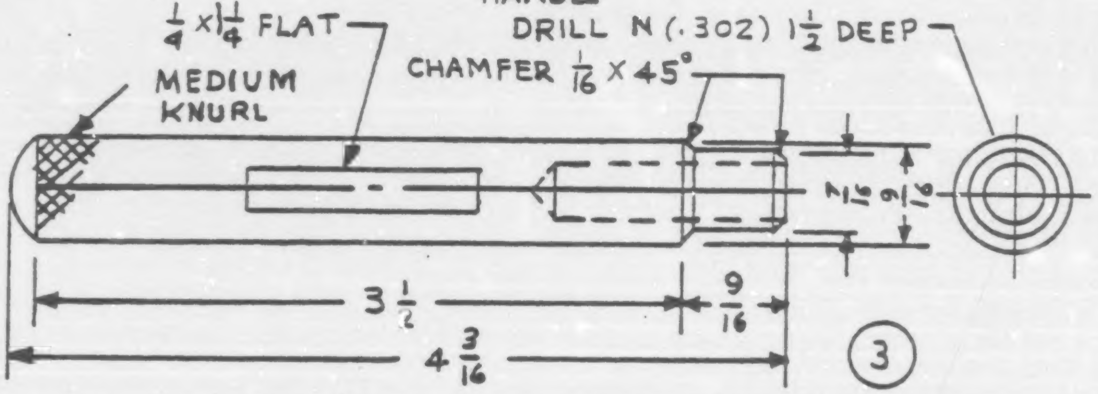
PARTS LIST

NO.	NAME	MAT.	QUA.
1	HEAD	ST'L.	1
2	ROD	ST'L.	1
3	HANDLE	CRS.	1

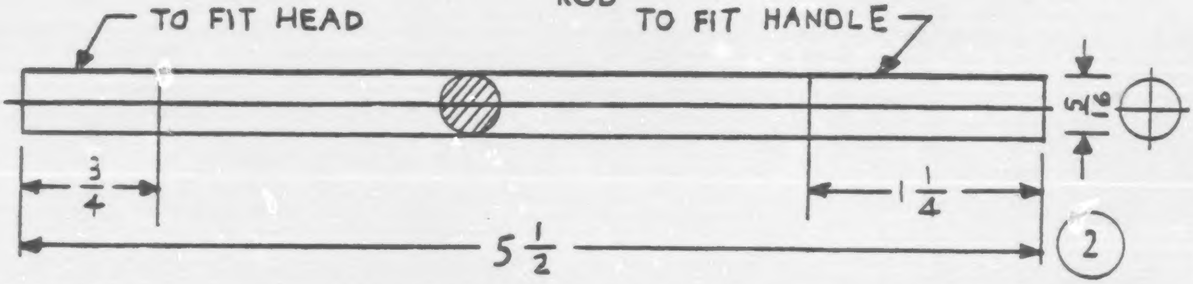
HEAD


N(.302) DRILL - 3/4 DEEP
7/16 R
11/16
11/16
7/8
1/16
11/16
3/8
3/8
5/8
1 5/16
2 3/4
①

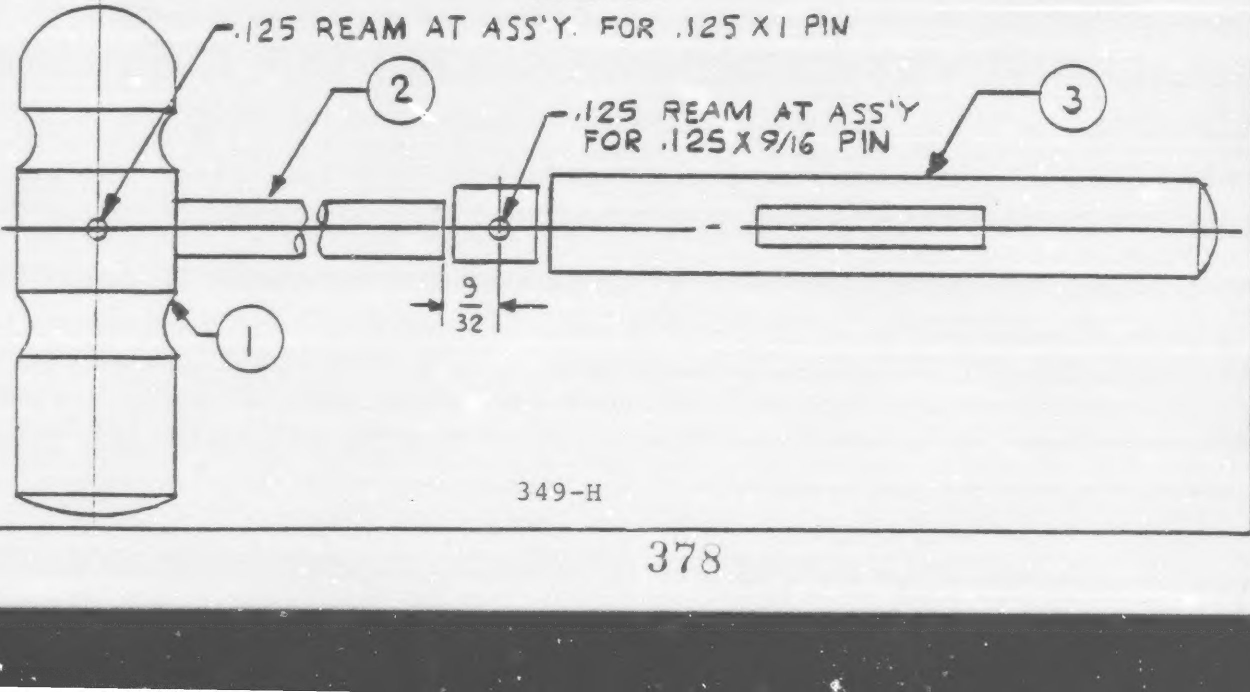
HANDLE


1/4 x 1 1/4 FLAT
DRILL N (.302) 1 1/2 DEEP
CHAMFER 1/16 x 45°
MEDIUM KNURL
7/16
9/16
3 1/2
9/16
4 3/16
③

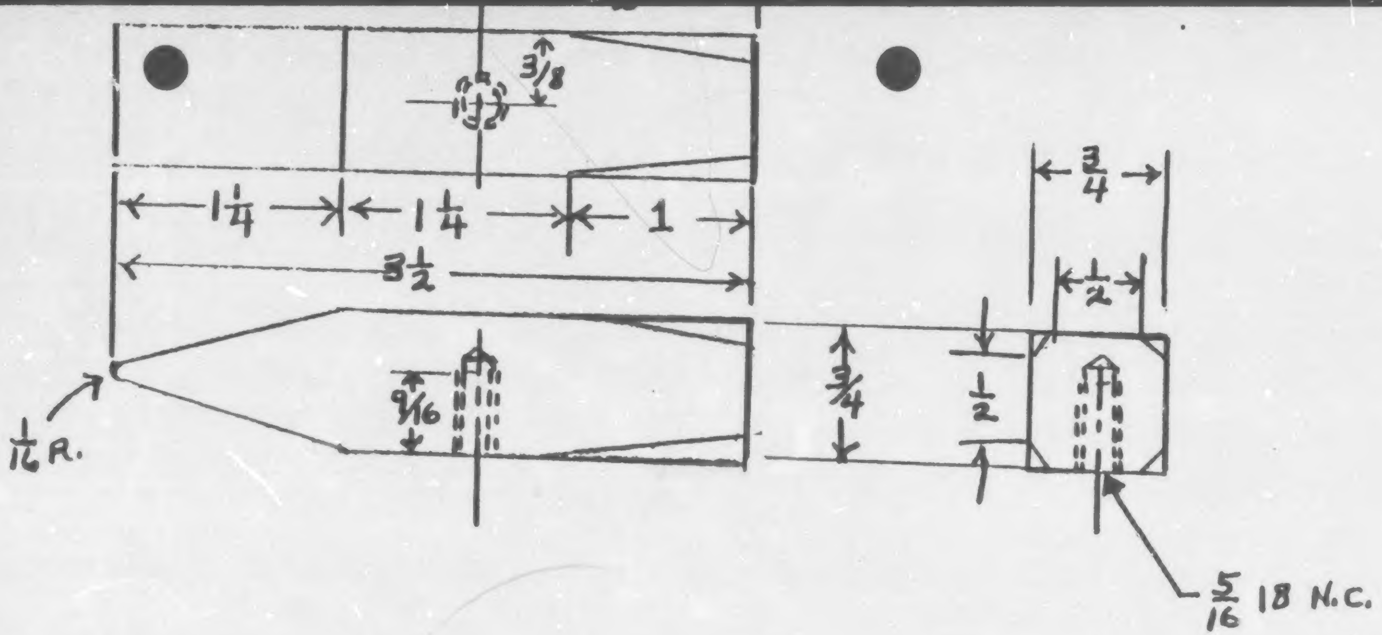
ROD

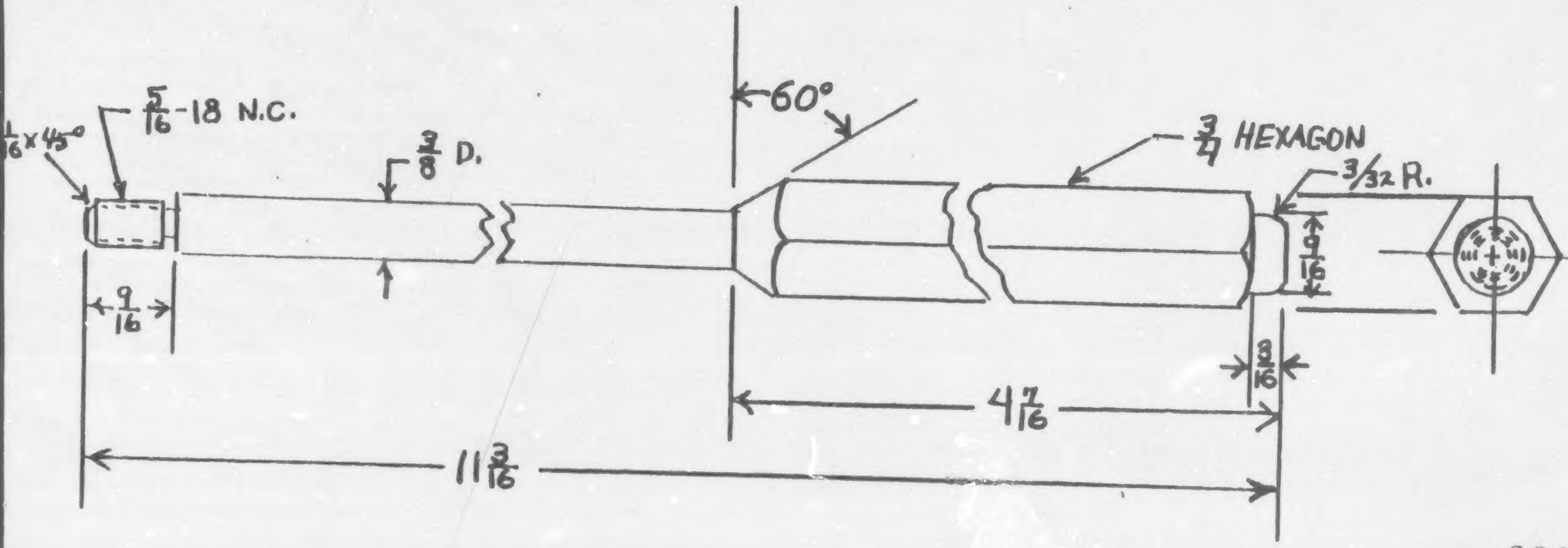

TO FIT HEAD
TO FIT HANDLE
5/16
3/4
1 1/4
5 1/2
②

ASSEMBLY


.125 REAM AT ASS'Y. FOR .125 X 1 PIN
②
.125 REAM AT ASS'Y FOR .125 X 9/16 PIN
③
9/32
①

349-H


3/8
1 1/4
1 1/4
1
3 1/2
1/16 R.
9/16
3/4
3/4
1/2
1/2
5/16 18 N.C.


1/16 x 45°
5/16-18 N.C.
3/8 D.
60°
3/4 HEXAGON
3/32 R.
9/16
9/16
3/16
4 7/16
11 3/16

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RIVETING HAMMER

SECOND YEAR MACHINE SHOP

SECOND YEAR

MACHINE SHOP - SECONDARY LEVEL

In practice, there appears to be no definite division between the first and second year of the Machine Shop instructional program. There probably will continue to be some overlap between the first year and second year of training at the secondary level because of a variation in the ability of students in mastering machining skills.

Typically, the first year of training will be completed after the mastery of most tasks in the Engine Lathe and Milling Machine units. Some advanced training on the engine lathe (e.g., tool post grinding) and on the milling machine (e.g., head alignment) may be included at the first of the secondary year of training.

Emphasis will be placed on the student mastering objectives in a sequence of simple to complex tasks and in a sequence of machine operations so that levels of employable skills (e.g., machine operator to machinist) are mastered as the student progresses through training.

The intent of the program is to provide that student with specific employable skills rather than to expose the student to a number of tasks which will not qualify the student for employment.

The secondary machine shop instructors report that they employ a sequence of similar instructor developed projects which progress in skill development to promote learning rather than a task-by-task method of instruction. As training and skills progress, projects involve tasks from a variety of units.

(NOTE: Second year Advanced Engine Lathe tasks are described in Unit 8: Tasks 8.24 - 8.29. Second year Advanced Mill Work tasks are described in Unit 9: Tasks 9.15 - 9.20, The "instructional planning time" for these advanced tasks is included in the second year description of Machine Shop.)

MACHINE SHOP
ADVANCED ENGINE LATHE WORK
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 8.0	ADVANCED ENGINE LATHE WORK	
8.24	Grind Workpiece with Tool Post Grinder	2
8.25	Machine External Taper	9
8.26	Machine Internal Taper	3
8.27	Machine External Angle	2
8.28	Machine Internal Angle	1
8.29	Set Up Lathe for Threading Operations	12
	TOTAL HOURS	29

ADVANCED MILL WORK
SUGGESTED INSTRUCTION TIME

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 9.0	ADVANCED MILL WORK	
9.15	Perform Indexing Operations	20
9.16	Perform Graduating and Marking Operations	3
9.17	Identify Types of Gears and Their Functions	3
9.18	Calculate Pitch, Diameters, Working Depth and Clearances for Machining Gears	9
9.19	Mill a Gear Rack	12
9.20	Machine a Spur Gear	6
	TOTAL HOURS	53

NOTE: See Units 8 and 9 for Task Descriptions.

UNIT 10.0

ADVANCED BLUEPRINT READING IN MACHINING

Advanced blueprint reading is designed to provide the second year machine shop student with a brief review of introductory principles and advance those knowledges and skills learned during the first year of training so the student will be able to interpret sectional views, metric or English dimensions and tolerances, and auxiliary views. Optional areas of learning include interpreting assembly drawings and bills of materials.

Upon completion of this unit of learning, the student should be able to interpret blueprints and make shop drawings of workpieces to be machined to the standards of the instructor.

While this unit is included in the second year description, the tasks may be learned during the first year program.

MACHINE SHOP
ADVANCED BLUEPRINT READING IN MACHINING
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 10.0	ADVANCED BLUEPRINT READING IN MACHINING	
10.01	Interpret Sectional Views	9
10.02	Determine Metric Dimensions and Tolerances from Blueprint Data	9
10.03	Interpret Auxiliary Views	9
10.04	Sketch Shop Drawings of Workpiece to be Machined	18
10.05	(OPTIONAL) Interpret Assembly Drawings	*
10.06	(OPTIONAL) Interpret an Assembly Drawing Bill of Materials	*
	TOTAL HOURS	45

*Optional

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 10.0	ADVANCED BLUEPRINT READING IN MACHINING
10.01	(Interpret Sectional Views) Provided with a selection of orthographic and sectional views complete with symbols, notations, dimensions, and tolerances, and the necessary references and other required materials; interpret the sectional views. All symbols, notations, dimensions, and tolerances must be identified.
10.02	(Determine Metric Dimensions and Tolerances from Blueprint Data) Provided with a blueprint with metric dimensions and tolerances, the necessary references and writing materials; determine the metric dimensions and tolerances given on the drawing using dimension lines, centerlines, projection lines, and views. Correct dimensions must be determined and tolerances must be identified with 100 percent accuracy.
10.03	(Interpret Auxiliary Views) Provided with sample orthographic and primary or secondary auxiliary views, and the necessary references and other materials; interpret given auxiliary views to determine the dimensions, symbols, notations, and tolerances needed for machining the represented parts.
10.04	(Sketch Shop Drawings of Workpiece to be Machined) Provided with specifications for workpiece to be machined, the necessary materials for a simple drawing; sketch shop drawing of the workpiece to be machined.
10.05	(Interpret Assembly Drawings) Given orthographic and isometric drawings of multiple part assemblies complete with dimensions, tolerances, symbols, and notations, and the necessary references or other materials; interpret the assembly drawings. All information needed to machine the assembly must be identified from each drawing.
10.06	(Interpret an Assembly Drawing Bill of Materials) Given an assembly drawing with a complete bill of materials or parts list, the necessary references and materials; interpret the bill of materials. All parts must be identified by piece number, name, quantity, material, and other specifications given in the parts list.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.01 INTERPRET SECTIONAL VIEWS

PERFORMANCE OBJECTIVE:

Provided with a selection of orthographic and sectional views complete with symbols, notations, dimensions, and tolerances, and the necessary references and other required materials; interpret the sectional views. All symbols, notations, dimensions, and tolerances must be identified.

PERFORMANCE ACTIONS:

10.0101 Interpret:

a. Alphabet of lines.
b. Section and cutting plane lines.

10.0102 Interpret (as required by instructor). (*See Related Technical Information below.)

a. Full section.
b. Half section.
c. Broken-out section.
d. Revolved section.
e. Removed section.
f. Offset section.
g. Aligned section, if required.
h. Conventional breaks, if required.

PERFORMANCE STANDARDS:

- Interpret sectional views from given drawings to identify symbols, notations, dimensions, and tolerances.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- *Identify/describe sectional view:
  a. full
  b. half
  c. broken-out
  d. rotated
  e. removed
  f. auxiliary
  g. assembly sections
- Explain purpose of sectional view.
- Describe procedures for interpreting a section.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.02 DETERMINE METRIC DIMENSIONS AND TOLERANCES FROM BLUEPRINT DATA

PERFORMANCE OBJECTIVE:

Provided with a blueprint with metric dimensions and tolerances, the necessary references and writing materials; determine the metric dimensions and tolerances given on the drawing using dimension lines, centerlines, projection lines, and views. Correct dimensions must be determined and tolerances must be identified with 100 percent accuracy.

PERFORMANCE ACTIONS:

10.0201 Interpret related terminology.

10.0202 Determine dimensions for the following geometrical shapes:

- a. Cylinders.
- b. Holes.
- c. Prisms.
- d. Miscellaneous shapes.
- e. Contour dimensions.

10.0203 Determine:

- a. Location dimensions.
- b. Rounded and shapes.
- c. Dimensions on and off views.
- d. Mating dimensions, etc.

10.0204 Determine dimensions and tolerances, for example.

- a. Basic hole system.
- b. Basic shaft system.
- c. Clearance fits.
- d. Interference fits.
- e. Transition fits.
- f. Running and sliding fits.
- g. Force fits.
- h. Location fits.

PERFORMANCE STANDARDS:

- Determine correct metric dimensions and tolerances with 100 percent accuracy from given blueprints containing metric dimensions and tolerances.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.02 DETERMINE METRIC DIMENSIONS AND TOLERANCES FROM BLUEPRINT DATA (Con't.)

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Solve mathematical problems involving metric numbers.
- Explain the metric system of measures, etc., used in machining.
- Explain purpose of dimensions and tolerances.
- Describe how metric dimensions and tolerance are represented on a blueprint.
- Describe the procedure for determining metric dimensions and tolerances from a blueprint.
- Explain the use of a scale in blueprints.
- Machinery's Handbook.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.03 INTERPRET AUXILIARY VIEWS

PERFORMANCE OBJECTIVE:

Provided with sample orthographic and primary or secondary auxiliary views, and the necessary references and other materials; interpret given auxiliary views to determine the dimensions, symbols, notations, and tolerances needed for machining the represented parts.

(NOTE: The relationship between the orthographic and auxiliary views must be interpreted through identifying the drawing position on the orthographic view.)

PERFORMANCE ACTIONS:

10.0301 Interpret depth, height, and width auxiliary views.

10.0302 Interpret auxiliary views of objects with symmetrical planes, asymmetrical planes, and curved surfaces.

PERFORMANCE STANDARDS:

- Interpret auxiliary views for dimensions, symbols, notations, and tolerances needed for machining the represented parts.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Explain relationship between auxiliary views and orthographic views.
- Define primary auxiliary view and secondary auxiliary view.
- Define procedure for interpreting auxiliary views.
- Make freehand sketches of auxiliary views using coordinate paper.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.04 SKETCH SHOP DRAWINGS OF WORKPIECE TO BE MACHINED

PERFORMANCE OBJECTIVE:

Provided with specifications for workpiece to be machined, the necessary materials for a simple drawing; sketch shop drawing of the workpiece to be machined.

*See STANDARDS for detailed requirements of drawing. Instructor's standards apply.

PERFORMANCE ACTIONS:

10.0401 Take dimensions and tolerances, etc., from given drawings as part sample.

10.0402 Draw part (workpiece) showing finishes, tolerances, etc.

10.0403 Sketch shop drawing for part to be machined.

PERFORMANCE STANDARDS:

- Sketch shop drawings of workpiece to be machined using information and materials provided by the instructor.
- *The shop drawing must have lines that are clean, dense, black, and of uniform weight. Letters and numbers must be clean, dense, black, and uniformly spaced. Dimensions, notations, and symbols must be applied to the drawing to allow a full understanding of the characteristics of each feature. Each dimension must have a tolerance, either applied directly or indicated by a notation. The drawings must be neat and free of smudges and erasure marks. All words should be spelled correctly, and the scale for the drawing must be applied to the requirements of the drawing. The product and procedures must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 18 Hours

RELATED TECHNICAL INFORMATION:

- Explain what should be included in the shop drawing (articulated requirement of program).
- Identify symbols, notations, and dimensions that should be indicated on drawing.

RELATED TECHNICAL INFORMATION (Con't.):

- Describe procedure for making a shop drawing.
- Explain how to draw lines: Use of T-square, drawing board, and triangles
- Explain how to read and transfer measurements.
- Demonstrate freehand lettering acceptable to instructor.
- Demonstrate methods of drawing circles, arc, and angles.

UNIT 10.0 ADVANCED BLUEPRINT READING

TASK 10.05 (Optional) INTERPRET ASSEMBLY DRAWING

PERFORMANCE OBJECTIVE:

Given orthographic and isometric drawings of multiple part assemblies complete with dimensions, tolerances, symbols, and notations, and the necessary references or other materials; interpret the assembly drawings. All information needed to machine the assembly must be identified from each drawing.

PERFORMANCE ACTIONS: (To be defined by instructor.)

PERFORMANCE STANDARDS:

- Interpret given assembly drawings identifying all information needed to machine the assembly such as dimensions, tolerances, symbols, and notations.

SUGGESTED INSTRUCTION TIME: Optional

RELATED TECHNICAL INFORMATION:

- Define assembly drawing.
- Explain purpose of 'balloons' in an assembly drawing.
- Explain how drawings indicate multiple parts joined together, finishes, parts, material, specifications, and tolerances.
- Describe the procedure for interpreting an assembly drawing.
- Make freehand sketches of assemblies and subassemblies using coordinate paper of plain paper with simple drawing equipment provided.

UNIT 11.0

TURRET LATHE

The purpose of this unit is to provide secondary machine shop students with an orientation to the turret lathe.

The turret lathe in the secondary machine shop program typically will vary according to its age and condition as well as according to the availability of accessories required for its use.

Therefore, this unit on the turret lathe may be considered either as skill development training or orientation training. In addition, instructional and maintenance funds at the secondary level have not encouraged maintenance, equipping, use of the turret lathe for training .

Optional orientation tasks are listed at the back of this unit for advanced or individual training on the turret lathe.

MACHINE SHOP
TURRET LATHE
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 11.0 TURRET LATHE		
11.01	Identify Turret Lathe	4
11.02	Clean and Lubricate the Turret Lathe	2
11.03	Identify Workholding Devices	2
11.04	Identify Chucking Operations on the Turret Lathe	4
11.05	Identify Standard Tool Holding Devices for Turret Lathe	4
11.06	Select Cutting Speed and Feed	4
11.07	Identify Coolants	4
	TOTAL HOURS	24

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 11.0 TURRET LATHE	
11.01	(Identify Turret Lathe) Given a turret lathe and instructions; name and describe the function of the parts of the turret lathe correctly.
11.02	(Clean and Lubricate the Turret Lathe) Given a turret lathe and maintenance/cleaning instructions and all necessary tools, cleaning supplies, and materials; clean and lubricate.
11.03	(Identify Workholding Devices) Given several types of workholding devices for the turret lathe, identify the type of collet and chuck and describe function of the device to the satisfaction of the instructor.
11.04	(Identify Chucking Operations of the Turret Lathe) Given a turret lathe, and assigned task, stock, chucks, and hand tools; choose the correct chuck for the job and mount the chuck according to correct shop procedures.
11.05	(Identify Standard Tool Holding Devices for Turret Lathe) Given an assortment of standard tool holding devices for the turret lathe, identify and describe correctly the devices to the instructor's standards.
11.06	(Select Cutting Speed and Feed) Given a workpiece, job assignment and specifications, turret lathe, accessories, tools and materials; set the speed and feed of the turret lathe correctly for the given material. The speed and feed selected must be acceptable to the instructor.
11.07	(Identify Coolants) Given workpiece to cut on the turret lathe and necessary tools, accessories, and materials; select an appropriate coolant for the material to be cut. Performance must meet instructor's standards.

UNIT 11.0 TURRET LATHE

TASK 11.01 IDENTIFY TURRET LATHE

PERFORMANCE OBJECTIVE:

Given a turret lathe and instructions; name and describe the function of the parts of the turret lathe correctly.

PERFORMANCE ACTIONS:

11.0101 Identify turret lathe parts and their functions:

- a. Identify advantages of turret lathe.
- b. Identify disadvantages of turret lathe.
- c. Identify special features of the turret lathe:
  - (1) Trip feed
  - (2) Stop screws
- d. Describe operations which can be performed on the turret lathe.
- e. Identify the parts of a given turret lathe that is labeled.

PERFORMANCE STANDARDS:

- Identify the turret lathe including correct identification of the parts of a given lathe to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Identify/describe parts of the turret lathe.

UNIT 11.0 TURRET LATHE

TASK 11.02 CLEAN AND LUBRICATE THE TURRET LATHE

PERFORMANCE OBJECTIVE:

Given a turret lathe and maintenance/cleaning instructions and all necessary tools, cleaning supplies, and materials; clean, and lubricate.

PERFORMANCE ACTIONS:

11.0201 Assemble cleaning materials, instructions, etc.

11.0202 Disconnect power.

11.0203 Clean lathe according to instructions.

11.0204 Lubricate lathe according to instructions.

PERFORMANCE STANDARDS:

- Clean and maintain the turret lathe according to manufacturer's or instructor's standards (shop procedures) by cleaning, lubricanting, leveling, and making adjustments as instructed.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Explain the value of a shop maintenance schedule.
- Describe how to clean the turret lathe.
- Describe the procedure for lubricating a lathe.
- Identify acceptable types of cleaning solvents.
- Identify acceptable lubricants and greases.
- Identify safety hazards of the turret lathe:
  a. Machine speed
  b. Chip guards
  c. Personal safety devices such as clothing
  d. Safe operating procedures for the turret lathe
  e. Starting and stopping the lathe

UNIT 11.0 TURRET LATHE

TASK 11.03 IDENTIFY WORKHOLDING DEVICES

PERFORMANCE OBJECTIVE:

Given several types of workholding devices for the turret lathe, identify the type of collet and chuck and describe the function of the device to the satisfaction of the instructor.

PERFORMANCE ACTIONS:

11.0301 Identify types of chucks and collets used on the turret lathe in the machine shop.

(NOTE: The age, condition, and accessories of the turret lathe available for training will vary and, therefore, this task will require local adaptation.)

11.0302 Describe functions of selected workholding devices used with the turret lathe.

PERFORMANCE STANDARDS:

- Identify workholding devices used by the shop turret lathe and describe the function of the devices to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Describe the collet chuck.
- Describe the three-jaw chuck.
- Describe the four-jaw chuck.
- Describe bar chucks.
- Describe closing type collet chuck.
- Describe spring type collets:
  a. Push out type
  b. Draw back type
  c. Stationary type
- Describe power operated collet chuck.

UNIT 11.0 TURRET LATHE

TASK 11.04 IDENTIFY CHUCKING OPERATIONS ON THE TURRET LATHE

PERFORMANCE OBJECTIVE:

Given a turret lathe, an assigned task, stock, chucks, and hand tools; choose the correct chuck for the job and mount the chuck according to correct shop procedures.

PERFORMANCE ACTIONS:

11.0401 Choose an appropriate chuck for a specified job and mount it on the turret lathe.

PERFORMANCE STANDARDS:

- For a given job, select the correct chuck and mount it on the turret lathe according to shop practices.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Choose a holding device for chucking work.
- Describe the purpose of holding devices in chucking.
- Identify the following types of chucks:
  a. Universal
  b. Independent
  c. Combination
  d. Power operated types
- Explain the function of chuck jaws.
- Describe how to mount a chuck.
- Describe how to select a chuck.

UNIT 11.0 TURRET LATHE

TASK 11.05 IDENTIFY STANDARD TOOL HOLDING DEVICES FOR TURRET LATHE

PERFORMANCE OBJECTIVE:

Given an assortment of standard toolholding devices for the turret lathe, identify and describe correctly the devices to the instructor's standards.

PERFORMANCE ACTIONS:

11.0501 Identify standard turret lathe toolholding devices available.

PERFORMANCE STANDARDS:

- Identify standard toolholding devices for the turret lathe to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Identify the objectives of a turret lathe job.
- Describe the elements of production time.
- Identify/describe universal tooling equipment.
- Describe/explain indexing.
- Explain the arrangement of tools.
- Identify types of tools and how they are applied.
- Identify safety considerations.

UNIT 11.0 TURRET LATHE

TASK 11.06 SELECT CUTTING SPEED AND FEED

PERFORMANCE OBJECTIVE:

Given a workpiece, job assignment and specifications, turret lathe, accessories, tools and materials; set the speed and feed of the turret correctly for the given material. The speed and feed selected must be acceptable to the instructor.

PERFORMANCE ACTIONS:

11.0601 Set the turret lathe speeds and feeds for a given job.

PERFORMANCE STANDARDS:

- Select cutting speed and feed for a given job and to meet the standards of the instructor.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Identify factors which affect speed and feed.
- Describe how to determine feed and speed.
- Describe how to set feed and speed on turret lathe.
- Describe the relationship of quantity of parts verses speed of operation.

UNIT 11.0 TURRET LATHE

TASK 11.07 IDENTIFY COOLANTS

PERFORMANCE OBJECTIVE:

Given workpiece to cut on the turret lathe and necessary tools, accessories, and materials; select an appropriate coolant for the material to be cut. Performance must meet instructor's standards.

PERFORMANCE ACTIONS:

11.0701 Choose appropriate coolant for a given workpiece to be cut on the turret lathe.

PERFORMANCE STANDARDS:

- Identify coolants and select an appropriate coolant or cutting compound for a given workpiece to be cut on the turret lathe.
- Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 4 Hours

RELATED TECHNICAL INFORMATION:

- Describe purpose of coolants.
- Describe procedure for using a coolant.

ADDITIONAL TASKS FOR TURRET LATHE (Orientation task unless otherwise specified.)

(GIVEN: Turret lathe, necessary accessories, equipment, tools, materials, workpiece, and job specifications, as well as instruction.)

FACE TO SPECIFIED DIMENSIONS AND FINISH

- Describe facing
- Identify facing tools
- Describe the direction of the cut for finish facing
- Describe how to grind the facing tool
- Identify facing problems
- Explain how to choose the appropriate turret
- Describe/demonstrate how to set up the turret lathe for facing

FORM CUT ASSIGNED WORKPIECE TO SPECIFIED DIMENSIONS

- Describe forming
- Explain how to make combining cuts with a forming tool
- Describe types of forming cutters
- Describe how to grind a forming tool
- Identify materials which can be form cut
- Describe finish forming
- Explain how to use coolants
- Describe the procedure for form tooling
- Identify safety considerations

TURN WORKPIECE SPECIFIED DIMENSIONS: GRIND TOOLS TO CORRECT ANGLES AND SET UP BAR TURNER CUTTERS ON LATHE

- Describe the use of cutter bar tools
- Describe how to set angles of bar tools cutter
- Describe how to position and adjust rolls for bar turning
- Describe the purpose of rollers on the rest
- Describe use of V-back rests
- Describe how to use tool gauges

DRILL SPECIFIED HOLE(S) IN WORKPIECE TO SPECIFIED DIMENSIONS

- Select drills for given jobs
- Describe how to produce accurate holes
- Describe how to start drills
- Explain the use of drill holding devices
- Describe speeds and feeds of the chuck

BORE DRILLED HOLE IN WORKPIECE TO SPECIFIED DIMENSIONS

- Identify boring tool
- Describe how to bore drilled holes
- Describe how to ream holes
- Identify types of boring tool
- Identify type and use of boring bar
- Describe use of a boring bar
- Describe use of boring bar sleeves
- Describe adjustable boring toolholder
- Describe double-end tools
- Explain procedures for boring

REAM A DRILLED HOLE TO SPECIFIED DIMENSIONS

- Describe reamers
- Identify types of reamers
- Identify reamer holders
- Explain procedures for starting a reamer

CUT A CHAMFER OR GROOVE TO SPECIFIED DIMENSIONS WITH A GIVEN TOOL

- Describe chamfering on turret lathe
- Identify chamfering tools
- Describe how to use a cut-off tool
- Describe how to use threading tools
- Explain grooving process

CUT THREADS TO SPECIFIED DIMENSIONS

- Identify dies
- Identify taps
- Describe chasing attachments
- Describe how to cut threads using turret
- Describe how to cut large threads with single point tools
- Explain leading-on attachments
- Identify types of taps and dies
- Describe how to mount die heads
- Explain how to make roughing and finished cuts
- Describe roughing and finishing attachments

UNIT 12.0

SURFACE GRINDER

(NOTE: Bench and pedestal grinders are described in a separate unit.)

Grinder operations on the lathe are included in the unit concerning the engine lathe.

The purpose of this unit concerning the surface grinder is to introduce the secondary student to the surface grinder and provide the graduate with basic skills in inspecting, cleaning, setting up, and using the surface grinder. The skill level described is introductory and typically the secondary graduate will be competent only in the use of the surface grinder for grinding flat surfaces.

MACHINE SHOP
SURFACE GRINDER
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 12.0	SURFACE GRINDER	
12.01	Inspect and Clean a Surface Grinder	3
12.02	Set Up Surface Grinder for Flat Surface Operation	6
12.03	Grind Flat Surfaces	15
	TOTAL HOURS	24

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 12.0	SURFACE GRINDER
12.01	(Inspect and Clean a Surface Grinder) Given a horizontal-spindle surface grinder, manual or operator's instructions, cleaning materials selected by the instructor, and the necessary hand tools and equipment; inspect and clean the surface grinder according to the manufacturer's (or instructor's) specifications. The surface grinder and surrounding area must be free of metal chips, excess lubricant or cutting fluid, and foreign material.
12.02	(Set Up Surface Grinder for Flat Surface Operation) Given a horizontal-spindle surface grinder, operator's instructions, set up specifications, workpieces, grinding wheels, magnetic chuck, and the necessary hand tools, measuring instruments, and materials; set up the surface grinder for flat surfacing operations. The workpiece, magnetic chuck, and grinding wheel must be aligned with the table +/- .001 inch. The correct grinding wheel must be selected and mounted on the wheel spindle so that the wheel turns true.
12.03	(Grind Flat Surfaces) Given workpieces requiring flat surfaces machined to a surface expressed in micro-inches, dimensioned blueprints or drawings, grinding specifications, grinding wheels, magnetic chuck, and the necessary hand tools, attachments, accessories, measuring instruments, and materials; grind the flat surfaces using the horizontal-spindle surface grinder. The workpieces must be surface ground to specifications with a tolerance identified by the instructor. (32-125 micro-inches if not specified).

UNIT 12.0 SURFACE GRINDER

TASK 12.01 INSPECT AND CLEAN A SURFACE GRINDER

PERFORMANCE OBJECTIVE:

Given a horizontal-spindle surface grinder, manual or operator's instructions, cleaning materials selected by the instructor, and the necessary hand tools and equipment; inspect and clean the surface grinder according to the manufacturer's (or instructor's) specifications. The surface grinder and surrounding area must be free of metal chips, excess lubricant or cutting fluid, and foreign material.

PERFORMANCE ACTIONS:

12.0101 Identify surface grinder as horizontal or vertical spindle.

12.0102 Identify major parts of surface grinder to instructor's standards.

12.0103 Inspect surface grinder to instructor's standards.

12.0104 Clean surface grinder according to recommendations of manufacturer or instructor.

PERFORMANCE STANDARDS:

- Inspect and clean a surface grinder to specifications given so that the machine and surrounding area are free of metal chips, excess lubricant or cutting fluid, and foreign material.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- ORIENTATION TO SURFACE GRINDER:
  - Identify type of surface grinder: Vertical or horizontal
  - Identify major parts of surface grinder such as the base, column, saddle, table, wheelhead, and operating controls such as table handwheel, wheel feed handwheel, crossfeed handwheel, and other controls.
- CLEANING A SURFACE GRINDER:
  - Explain reasons for performing routine inspection and cleaning of the surface grinder.
  - Identify materials recommended by manufacturer or instructor for cleaning surface grinder.
  - Identify safety considerations.

RELATED TECHNICAL INFORMATION (Con't.):

- Describe procedures for inspecting and cleaning the surface grinder.
- Review manufacturer's recommendations/specifications for the machine.
- Assemble cleaning materials, tools.
- Turn power off to machine.
- Clean grinder:
  a. Remove chips with brush.
  b. Clean machine with cleaner and rags.
- Lubricate grinder according to instructions provided (manufacturer's information or instructor's standards):
  a. Oil in oil cups.
  b. Grease fittings.
  c. Oil slides and machined surfaces lightly.
- Remove grinding wheel:
  a. Ring test for cracks.
  b. Replace wheel if it is damaged.
  c. Check blotters and flanges.
- Replace wheel and check wheel cover and guards:
  a. Never mount a wheel without using washers of some compressible material.
  b. Never force wheels on mounting.
  c. Take care in tightening nut against flange.
  d. If necessary, with instructor's permission, dress wheel that is glazed or "loaded."
- Check exhaust system, if applicable.
- Inspect grinder and surrounding area.

UNIT 12.0 SURFACE GRINDER

TASK 12.02 SET UP SURFACE GRINDER FOR FLAT SURFACE OPERATION

PERFORMANCE OBJECTIVE:

Given a horizontal-spindle surface grinder, operator's instructions, set up specifications, workpieces, grinding wheels, magnetic chuck, and the necessary hand tools, measuring instruments, and materials; set up the surface grinder for flat surfacing operations. The workpiece, magnetic chuck, and grinding wheel must be aligned with the table +/- .001 inch. The correct grinding wheel must be selected and mounted on the wheel spindle so that the wheel turns true.

PERFORMANCE ACTIONS:

12.0201 Set up surface grinder for desired operation.

12.0202 Prepare grinding wheel for operation.

12.0203 Select holding device and mount it on grinder.

12.0204 Mount workpiece.

(See procedures outlined in Grinding Technology, by Oswald, Delmar Publishers, pp. 107-110.)

PERFORMANCE STANDARDS:

- Set up the surface grinder for a flat surface operation.
- The workpiece, magnetic chuck, and grinding wheel must be aligned with the table +/- .001 inch.
- The correct grinding wheel must be selected and mounted on the wheel spindle so that the wheel runs true.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify the basic parts and controls of the surface grinder.
- Identify applications for machining with a surface grinder.
- Define surface finish and explain how to measure a finish in micro-inches.
- Explain purpose of table reverse dogs.
- Explain how to set up magnetic, electromagnetic, and sine chucks on a surface grinder.

UNIT 12.0 SURFACE GRINDER

TASK 12.02 SET UP SURFACE GRINDER FOR FLAT SURFACE OPERATION

RELATED TECHNICAL INFORMATION (Con't.):

- Define procedure for setting up a surface grinder.
- Explain how to mount flat, thin, short, and non-magnetic workpieces.
- Explain why grinding wheel should clear the workpiece at each end by approximately 1 inch.
- Identify safety considerations.

UNIT 12.0 SURFACE GRINDER

TASK 12.03 GRIND FLAT SURFACES

PERFORMANCE OBJECTIVE:

Given workpieces requiring flat surfaces machined to a surface expressed in micro-inches, dimensioned blueprints or drawings, grinding specifications, grinding wheels, magnetic chuck, and the necessary hand tools, attachments, accessories, measuring instruments, and materials; grind the flat surfaces using the horizontal-spindle surface grinder. The workpieces must be surface ground to specifications with a tolerance of 32-125 micro-inches.

PERFORMANCE ACTIONS:

12.0301 Select proper grinding wheel for job.

12.0302 Mount grinding wheel on spindle.

12.0303 True and dress grinding wheel as required.

12.0304 Examine magnetic chuck for burrs, removing them as required.

12.0305 Remove all burrs from workpiece.

12.0306 Place a piece of paper slightly larger than the workpiece in the center of the chuck.

12.0307 Mount workpiece and energize chuck, and check that it is securely fastened.

12.0308 Adjust table reverse dogs so that center of grinding wheel clears each end of work by about 1 inch.

12.0309 Set crossfeed for type of grinding operation. (Generally .030 to .050 feed is a starting point.)

12.0310 Adjust table by hand until edge of grinding wheel overlaps workpiece by about 1/8 inch.

12.0311 Start grinder.

12.0312 Carefully lower wheelhead until grinding wheel just sparks work. Then, raise wheel .005 inch to clean any high spots on work. (Alternate method: With table moving, lower wheelhead until wheel sparks on high spot of workpiece.)

UNIT 12.0 SURFACE GRINDER

TASK 12.03 GRIND FLAT SURFACES

PERFORMANCE ACTIONS (Con't.):

12.0313 Feed entire workpiece across wheelface to check for high spots.

12.0314 Lower wheelhead .002 - .005 inch for roughing cut. (Reduce table speed when taking roughing cuts.)

12.0315 Apply coolant to clean grinding wheel and cool workpiece (if machine has coolant system).

12.0316 Engage crossfeed and take roughing cut across workpiece.

12.0317 Prior to setting the depth of cut (to prevent grinding surface from being damaged), check to ensure that the grinding wheel completely clears the edge of the workpiece.

12.0318 Take the necessary rough cuts to remove machine marks and bring work close to required specifications.

12.0319 Finish dress grinding wheel.

12.0320 Lower wheel .005 to .001 inch for finish cut.

12.0321 Adjust table traverse speed to produce finish desired.

12.0322 Shut off coolant and stop table.

12.0323 Allow wheel to revolve for about 1/2 minute to remove coolant.

12.0324 Shut off grinder.

PERFORMANCE STANDARDS:

- Grind flat surfaces to specifications with a tolerance of 32-125 micro-inches.

SUGGESTED INSTRUCTION TIME: 15 Hours

RELATED TECHNICAL INFORMATION:

- Identify setup requirements for grinding flat surfaces on surface grinder.
- Explain how to dress a grinding wheel for a flat surface operation.
- Identify coolant used in surface grinding.
- Describe the procedure for grinding a flat surface.
- Explain why the grinding wheel should overlap the edge of a workpiece during flat surfacing.
- Explain why high spots are ground off before the workpiece is flat surfaces.
- Explain how to make roughing and finishing cuts with the surface grinder.
- Identify safety considerations.
- Principles of plain grinding.
- Principles of face grinding.

POSSIBLE EXPANSION OF TECHNICAL TOPICS:

- Groove and flute grinding.
- Profile or form grinding.
- Step grinding.

TASKS OMITTED FROM SURFACE GRINDING UNIT

(SECONDARY LEVEL)

These task may be included at the option of the instructor.

GRIND VERTICAL SURFACES

Given a horizontal-spindle surface grinder set up for grinding vertical surfaces, workpieces requiring vertical surfaces machined to a surface finish expressed in micro-inches, dimensioned blueprints or drawings, grinding specifications, grinding wheels, a magnetic chuck, and the necessary hand tools, attachments, accessories, measuring instruments, and materials; grind the vertical surfaces. The workpieces must be ground to specifications with a tolerance of 32-125 micro-inches.

SQUARE WORKPIECE

Given a horizontal-spindle surface grinder, workpiece that requires grinding on all sides to a surface finish expressed in micro-inches, a detail drawing, grinding specifications, grinding wheels, a magnetic chuck and angle plate, and the necessary hand tools, attachments, accessories, measuring instruments, and materials; square the workpiece by surface grinding on all sides. The workpiece must be ground square (+/- 5 minutes) and parallel (+/- .002 inch) and surface finished to specified requirements expressed in 32-125 micro-inches.

GRIND ANGULAR SURFACES

Given a horizontal-spindle surface grinder set up for angular grinding, workpieces requiring angular surfaces ground to a surface finish expressed in micro-inches, detail drawings, grinding specifications, grinding wheels, a magnetic chuck, angle plate, sine bar, gauge blocks, and the necessary hand tools, attachments, accessories, measuring instruments, and materials, grind the angular surfaces. The workpieces must be ground to specifications with a tolerance of 32-125 micro-inches.

UNIT 13.0

SHAPER

The objective of this unit on the shaper machine is to provide the student with knowledge on how to set up a shaper and make rough and finished cuts.

MACHINE SHOP
SHAPER
SUGGESTED INSTRUCTION TIME

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 13.0 SHAPER		
13.01	Inspect and Clean a Shaper	2
13.02	Identify Types, Sizes, Construction, Specifications, Nomenclature, and Range of Work for Shapers	6
13.03	Set Up Shaper for Machining Operations, Set Speed and Feed	6
13.04	Make a Rough and Finished Horizontal Cut	6
13.05	Shape Flat Surfaces	3
13.06	Shape Angular Surfaces	6
	TOTAL HOURS	29

TASK LISTINGS
MACHINE SHOP

UNIT/TASK **DESCRIPTION**

Unit 13.0 SHAPER

13.01 (Inspect and Clean a Shaper) Given a horizontal shaper, operator's instructions, cleaning materials, and the necessary hand tools or equipment; inspect and clean the shaper and according to instructions given. The shaper and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.

13.02 (Identify Types, Sizes, Construction, Specifications, Nomenclature, and Ranges of Work for Shapers) Given a shaper with parts marked or tagged, identify each part tagged and describe the function of each part with 100 percent accuracy.

13.03 (Set Up Shaper for Machining Operations, Set Speed and Feed) Given a horizontal shaper, setup specifications, workpieces, cutting tools and attachments, a dial indicator, and the necessary hand tools, measuring instruments, and materials; set up the shaper for various machining operations. The correct cutting tools must be selected, secured, and aligned. The workpiece, attachments, and cutting tools must be aligned with the table and toolhead to specifications with a tolerance of +/- .001 inch.

For given shaper operation, calculate speed and feed and set machine up within 10 percent of instructor's calculations, conforming to Machinery's Handbook.

Set up shaper, align shaper attachments, workpiece, and cutter. Cutting toolhead and side clearance must be within 4 degrees. Ram stroke must clear workpiece on forward stroke by 1/4 inch, and 1/2 inch on return stroke.

13.04 (Make a Rough and Finished Horizontal Cut) Given a horizontal Shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal roughing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instructions, and materials; make roughing cuts in the workpiece. The stock must be rough cut to specified depth to cut using consecutive 1/8 inch cuts. The roughing cuts must allow for finishing cut of .005 inch.

Given a horizontal shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal finishing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instruments, and materials, make finishing cuts using consecutive .005 inch cuts with a tolerance of +/- .005 inch for dimensions.

13.05 (Shape Flat Surfaces) Given a horizontal shaper, workpieces requiring flat surfaces, detail drawings, shaping specifications, cutting tools and holders, attachments, and the necessary hand tools, measuring instruments, and materials; shape flat surfaces on the workpieces. The workpieces must be machined to specifications with a tolerance of +/- .001 inch.

13.06 (Shape Angular Surfaces) Given a horizontal shaper, workpieces requiring angular surfaces, detail drawings, shaping specifications, cutting tools and holders, attachments, and the necessary hand tools, measuring instruments, and materials; shape angular surfaces on the workpiece. The workpieces must be machined to specifications with a tolerance of +/- 1/2 degree.

UNIT 13.0 SHAPER

TASK 13.01 INSPECT AND CLEAN A SHAPER

PERFORMANCE OBJECTIVE:

Given a horizontal shaper, operator's instructions, cleaning materials, and the necessary hand tools or equipment; inspect and clean the shaper according to instructions given. The shaper and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.

PERFORMANCE ACTIONS:

13.0101 Review specifications for cleaning shaper.

13.0102 Assemble materials, tools, etc., required to clean shaper.

13.0103 Inspect shaper for maintenance needs, etc.

13.0104 Clean and care for the shaper to specifications making necessary adjustments and providing daily maintenance.

PERFORMANCE STANDARDS:

- Inspect and clean a shaper according to instruction provided and so that the surrounding area is free of metal chips, excess lubricant and cutting fluid, and foreign material.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Explain reasons for performing routine inspection and cleaning of shaper.
- Describe procedure for inspecting and cleaning a shaper.
- Identify materials used to clean the shaper.
- Identify safety considerations.
- Manufacturer's specifications for cleaning shaper.

UNIT 13.0 SHAPER

TASK 13.02 IDENTIFY TYPES, SIZES, CONSTRUCTION, SPECIFICATIONS, NOMENCLATURE, AND RANGES OF WORK FOR SHAPERS

PERFORMANCE OBJECTIVE:

Given a shaper with parts marked or tagged, identify each part tagged and describe the function of each part with 100 percent accuracy.

PERFORMANCE ACTIONS:

13.0201 Identify the parts and components of the shaper.

13.0202 Describe function of each part with 100 percent accuracy and meet instructor's standards.

PERFORMANCE STANDARDS:

- Identify shaper parts tagged and describe the function of each part to the instructor's standards with 100 percent accuracy.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Describe/identify:
    - Function of shaper (cuts that can be made)
    - Ram motion
    - Type shaper: Horizontal or vertical
    - Ratchet and paw mechanism
    - Work table
    - Clapper
    - Apron
    - Power rapid-traverse lever
    - Gib and gib adjustments
    - Collants and cutting fluids

UNIT 13.0 SHAPER

TASK 13.03 SET UP SHAPER FOR MACHINING OPERATIONS, SET SPEED AND FEED

PERFORMANCE OBJECTIVES:

Given a horizontal shaper, setup specifications, workpieces, cutting tools and attachments, a dial indicator, and the necessary hand tools, measuring instruments, and materials; set up the shaper for various machining operations. The correct cutting tools must be selected, secured, and aligned. The workpiece, attachments, and cutting tools must be aligned with the table and tool head to specifications with a tolerance of +/- .001 inch.

For given shaper operation, calculate speed and feed and set machine up within 10 percent of instructor's calculations, conforming to Machinery's Handbook.

Set up shaper, align shaper attachments, workpiece, and cutter. Cutting tool head and side clearance must be within 4 degrees. Ram stroke must clear workpiece on forward stroke by 1/4 inch, and 1/2 inch on return stroke.

PERFORMANCE ACTIONS:

13.0301 Select and set machine speed:

a. Identify and classify workpiece material.
b. Determine desired cutting speed by using formula or table.
c. Using formula, approximate machine speed in cutting strokes per minute.
d. Set driving gear or butt wheel to proper machine speed.

13.0302 Select and set for cutting speed:

a. Identify and classify material of workpiece.
b. Identify cutter material to be used.
c. Determine cutting speed by using table specifications.
d. Determine setting of cutting speed based on desired length of cut and shaper strokes per minute.
e. Set shaper for desired cutting speed by using operations manual.

PERFORMANCE ACTIONS (Con't.):

13.0303 Select and set feed:

a. Identify and classify material of workpiece.
b. Identify cutter material.
c. Determine cutting speed.
d. Determine depth of cut needed.
e. Determine feed according to desired finish.
f. Set feed according to operations manual of instructions provided.

13.0304 Secure holding device.

13.0305 Mount and align key stock.

13.0306 Square workpiece to ram head.

13.0307 Replace key stock with workpiece.

13.0308 Adjust shaper and cutter to workpiece:

a. Adjust clapper box.
b. Adjust for clearance.
c. Adjust for length of stroke.

PERFORMANCE STANDARDS:

- Set up shaper for machine operations according to given specifications and machining operation(s).
- Correct cutting tools must be selected, secured, and aligned.
- Workpiece, attachment, and cutting tools must be aligned with the table and tool head to specifications with a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify following shaper components:
  a. Ram
  b. Pedestal
  c. Tool head
  d. Stroke indicator

UNIT 13.0 SHAPER

TASK 13.03 SET UP SHAPER FOR MACHINING OPERATIONS, SET SPEED AND FEED

RELATED TECHNICAL INFORMATION (Con't.):

e. Feed selector
f. Clutch
g. Stroke selector
h. Column
i. Table
j. Variable speed control
k. Cross rail
l. Saddle
m. Clapper box
n. Clapper block

- Explain basic operation of shaper in machining metal.
- Identify and explain applications of various types of shapers.
- Identify various types of shaper tool bits.
- Explain how to adjust shaper head.
- Explain how to mount workpiece in vise or bolt workpiece to table.

- Describe how to calculate speed and feed.
- Describe how to set strokes per minute (SPM).
- Describe how to set feed per minute (FPM).
- Describe how to take rough and finish cuts.
- Describe rocker arm adjustment.
- Describe how to set table feed.

- Describe stock length and shaper stroke.
- Identify final checks.
- Tell how to position tool slide.
- Describe clapper box and tool clearance.
- Describe how to position work in holder.
- Describe how to test for parallelism and squareness.
- Describe how to seat work in vise.
- Describe paper shimming.
- Explain how to align angle plate.
- Explain how to adjust ram for position and length of stroke.
- Describe how to adjust table.

UNIT 13.0 SHAPER

TASK 13.04 MAKE A ROUGH AND FINISHED HORIZONTAL CUT

PERFORMANCE OBJECTIVES:

Given a horizontal shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal roughing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instructions, and materials; make roughing cuts in the workpiece. The stock must be rough cut to specified depth to cut using consecutive 1/8 inch cuts. The roughing cuts must allow for finishing cut of .005 inch.

Given a horizontal shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal finishing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instruments, and materials, make finishing cuts in the workpiece. The finishing cuts must be made to specified depth of cut using consecutive .005 inch cuts, with a tolerance of +/- .005 inch for dimensions.

PERFORMANCE ACTIONS:

13.0401 Set up machine and make a rough and a finished horizontal cut.

PERFORMANCE STANDARDS:

- Make a rough and finished horizontal cut to the following specifications:
  a. Stock must be rough cut to specified depth of cut using consecutive 1/8 inch cuts. The roughing cuts must allow for finishing cut of .005 inch.
  b. The finishing cuts must be made to specified depth of cut using consecutive .005 inch cuts, with a tolerance of +/- .005 inch for dimensions.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- ROUGH CUTS:
  - Explain how to avoid springing workpiece in vise.
  - Explain setup requirements for making horizontal roughing cuts on workpiece.

RELATED TECHNICAL INFORMATION (Con't.):

- Calculate cutting speed and feed for making roughing cuts.
- Explain why tool slide should be set for as short as overhang as possible.
- Explain how controls operate movement, feed, and direction of cut.
- Identify roughing cut shaper tools and their applications.
- Describe procedure for making roughing cuts on shaper.
- Explain how to mount roughing tool in holder or tool post.
- Identify safety considerations.

- FINISH CUTS:
  - Identify finishing cut shaper tools and their applications.
  - Explain how to adjust shaper for a cut of .005 inch.
  - Explain how to precision measure the shaped workpiece.
  - Describe the procedure for making finished cuts on a workpiece.
  - Explain how to mount the finishing tool in the holder of tool post.
  - Identify safety considerations.

UNIT 13.0 SHAPER

TASK 13.05 SHAPE FLAT SURFACES

PERFORMANCE OBJECTIVE:

Given a horizontal shaper, workpieces requiring flat surfaces, detail drawings, shaping specifications, cutting tools and holders, attachments, and the necessary hand tools, measuring instruments, and materials; shape flat surfaces on the workpieces. The workpieces must be machined to specifications with a tolerance of +/- .001 inch.

PERFORMANCE ACTIONS:

13.0501 Set up shaper and make cuts to specifications.

PERFORMANCE STANDARDS:

- Shape flat surfaces to specifications with a tolerance of +/- .001 inch.

SUGGESTED INSTRUCTION TIME: 3 Hours

RELATED TECHNICAL INFORMATION:

- Explain relationship between feed direction and clapper box swing direction.
- Calculate correct length of stroke, cutting speed, and feed to be used for shaping a flat surface.
- Describe procedure for shaping a flat surface on a shaper.
- Explain why cutting fluid is used during a shaping operation.
- Explain how to surface finish a shaped workpiece.
- Identify safety considerations.

UNIT 13.0 SHAPER

TASK 13.06 SHAPE ANGULAR SURFACES

PERFORMANCE OBJECTIVE:

Given a horizontal shaper, workpieces requiring angular surfaces, detail drawings, shaping specifications, cutting tools and holders, attachments, and the necessary hand tools, measuring instruments, and materials; shape angular surfaces on the workpieces. The workpieces must be machined to specifications with a tolerance of +/- 1/2 degree.

PERFORMANCE ACTIONS:

13.0601 Set up and cut a compound angle to given specifications.

PERFORMANCE STANDARDS:

- Shape angular surfaces to specifications with a tolerance of +/- 1/2 degree.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Identify setup requirements for shaping angular surfaces on a shaper.
- Calculate correct length of stroke, cutting speed, and feed to be used for shaping an angular surface.
- Describe procedure for shaping an angular surface on a shaper.
- Explain how to surface an angular cut.
- Identify safety considerations.

EXPANSION OF TASK:

- Accurately machine a dove tail on the shaper to a tolerance of +/- .001 inch.

UNIT 14.0

TOOL AND CUTTER GRINDER

This unit, Tool and Cutter Grinder, is designed to provide the secondary machine shop student with an orientation to the tool and cutter grinder machine including how to clean and set up the tool and cutter grinder.

MACHINE SHOP
TOOL AND CUTTER GRINDER
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 14.0	TOOL AND CUTTER GRINDER	
14.01	Inspect and Clean a Tool and Cutter Grinder	2
14.02	Set Up a Tool and Cutter Grinder	20
14.03	Grind Tools	8
	TOTAL HOURS	30

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 14.0	TOOL AND CUTTER GRINDER
14.01	(Inspect and Clean a Tool and Cutter Grinder) Given a tool and cutter grinder, operator instructions, cleaning materials, and the necessary hand tools and equipment; inspect and clean the grinder according to specifications from the manufacturer or instructor. The grinder and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.
14.02	(Set Up a Tool and Cutter Grinder) Given a tool and cutter grinder, a selection of grinding wheels, operator's instruction, dressing tools, and the necessary equipment and materials; set up the tool and cutter grinder for various grinding operations. The grinding wheel must run true, and the grinding surface must not be loaded or glazed. The grinder must operate according to the manufacturer's specifications.
14.03	(Grind Tools) Given a tool and cutter grinder set up with a grinding tool attachment, grinding specifications, tools needing sharpening, and the necessary hand tools, measuring instruments, and materials; grind the tools.

UNIT 14.0 TOOL AND CUTTER GRINDER

TASK 14.01 INSPECT AND CLEAN A TOOL AND CUTTER GRINDER

PERFORMANCE OBJECTIVE:

Given a tool and cutter grinder, operator instructions, cleaning materials, and the necessary hand tools and equipment; inspect and clean the grinder according to specifications from the manufacturer or instructor. The grinder and surrounding area must be free of metal chips, excess lubricant and cutting fluid, and foreign material.

PERFORMANCE ACTIONS:

14.0101 Inspect and identify major parts and controls of tool and cutter grinder.

14.0102 Check points of lubrication and adjustment, and require periodic cleaning or maintenance.

14.0103 Clean the tool and cutter grinder according to specifications.

PERFORMANCE STANDARDS:

- Inspect and clean a tool and cutter grinder according to the manufacturer's specifications so that the grinder and surrounding area is free of metal chips, excess lubricant and cutting fluid, and foreign material.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Explain reasons for performing routine inspection and cleaning of a tool and cutter grinder.
- Describe procedures for inspecting and cleaning a tool and cutter grinder.
- Identify materials used to clean a tool and cutter grinder.
- Identify safety considerations.
- Identify major parts of a tool and cutter grinder:
  - pedestal
  - motor
  - grinding wheel
  - tool rest
  - wheel guard
  - coolant reservoir
  - tool grinding attachment
  - power switch

UNIT 14.0 TOOL AND CUTTER GRINDER

TASK 14.02 SET UP A TOOL AND CUTTER GRINDER

PERFORMANCE OBJECTIVE:

Given a tool and cutter grinder, a selection of grinding wheel, operator's instruction, dressing tools, and the necessary equipment and materials; set up the tool and cutter grinder for various grinding operations. The grinding wheel must run true, and the grinding surface must not be loaded or glazed. The grinder must operate according to the manufacturer's specifications.

PERFORMANCE ACTIONS:

14.0201 Set up a tool and cutter grinder according to given instructions.

PERFORMANCE STANDARDS:

- Set up a tool and cutter grinder according to manufacturer's (instructor's) specifications so that the grinding wheel runs true and the grinding surface is not loaded or glazed.
- The grinder must operate according to the manufacturer's specifications.

SUGGESTED INSTRUCTION TIME: 20 Hours

RELATED TECHNICAL INFORMATION:

- Identify part of tool and cutter grinder.
- Identify machine tool cutters and tool bits that can be sharpened using the grinder.
- Identify grinding machine steel, oil-hardened tool steel, carbide, and cast iron.
- Identify defects and types of damage to grinding wheels.
- Identify operating speeds used for various grinding operations.
- Explain how to mount and balance a grinding wheel.
- Identify types of wheel dressers.
- Explain how to true and dress a grinding wheel.
- Describe procedures for setting up a tool and cutter grinder for specified operations.
- Describe truing and dressing, speeds and feeds.
- Describe procedures for sharpening, grinding, and reshaping machine shop tools.
- Identify safety considerations.
- Machinery's Handbook.

UNIT 14.0 TOOL AND CUTTER GRINDER

TASK 14.03 GRIND TOOLS

PERFORMANCE OBJECTIVE:

Given a tool and cutter grinder set up with a grinding tool attachment, twist drill specifications, tools needing sharpening, and the necessary hand tools, measuring instruments, and materials; grind the tools.

PERFORMANCE ACTIONS:

14.0301 Grind tools to specifications following instructions given.

PERFORMANCE STANDARDS:

- Grind tools to specifications.
- Performance process and product must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: 8 Hours

RELATED TECHNICAL INFORMATION:

- Identify amount of lip clearance a twist drill must have a drill correctly.
- Explain why a twist drill must have equal angles and lengths on both flutes.
- Identify the following parts of a twist drill:
  - tang
  - shank
  - axis of drill
  - body
  - flute
  - land
  - margin
  - cutting edge of lip
  - lip clearance
  - dead center
  - web
- Identify angle and flute length specifications for various twist drills.
- Describe the procedure for sharpening a twist drill.
- Explain how to set up and mount a twist drill in a drill grinding attachment.
- Identify safety considerations.

CYLINDRICAL GRINDER UNIT

OMITTED FROM GUIDE

The cylindrical grinder has been omitted from the guide because secondary career center machine shop programs do not include cylindrical grinder machinery.

UNIT 15.0

HEAT TREATMENT

The purpose of this unit is to introduce the secondary machine shop student to basic heat treatment processes that can be employed to anneal, harden, and temper workpieces.

MACHINE SHOP
HEAT TREATMENT
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 15.0	HEAT TREATMENT	
15.01	Test Workpiece for Hardness	9
15.02	Anneal Workpiece	6
15.03	Harden and Temper a Workpiece	6
15.04	Harden Given Small Tools	3
	TOTAL HOURS	24

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 15.0	HEAT TREATMENT
15.01	(Test Workpiece for Hardness) Given an assortment of metal workpieces (steel, unhardened steel, soft-temper steel, and cast iron), test blocks with hardness tester and Comparative Hardness Scales (use Rockwell tests to determine hardness of samples). The correct hardness numbers must be taken from the Scale based on the readings resulting from the tests on the samples. Reading taken must agree with the readings taken by the instructor.
15.02	(Anneal Workpiece) Given heat treating equipment, hardened workpiece, specifications, and the necessary tools and materials; anneal the workpiece. The stock must be annealed to specifications of the instructor.
15.03	(Harden and Temper a Workpiece) Given a furnace for hardening and tempering operations, workpiece(s), quenching solutions, a chart of heat treatment specifications, a hardeness testing procedure outlined by the instructor, workbench, file, tongs, and the necessary materials; (a) harden and (b) temper the workpiece(s). The stock must be hardened and tempered to the specifications of the instructor.
15.04	(Harden Given Small Tools) Given heat treatment equipment (task), necessary tools, materials, and specifications, and small tools such as cold chisels, punches, screwdrivers, etc., that can be hardened in the machine shop; harden the given small tools to the standards of the instructor.

UNIT 15.0 HEAT TREATMENT - HARDNESS TEST
TASK 15.01 TEST WORKPIECE FOR HARDNESS

PERFORMANCE OBJECTIVE:

Given an assortment of metal workpieces (steel, unhardened steel, soft-temper steel, and cast iron), test blocks with hardness tester and Comparative Hardness Scales (use Rockwell tests to determine hardness of samples). The correct hardness numbers must be taken from the Scale based on the readings resulting from the tests on the samples. Reading taken must agree with the readings taken by the instructor.

PERFORMANCE ACTIONS:

15.0101 Adjust hardness tester.

15.0102 Apply minor load or 10 kg.

15.0103 Set dial to zero.

15.0104 Apply major load.

15.0105 Remove major load.

15.0106 Take reading while minor load is still applied*.

15.0107 Derive hardness number from Scale based on reading from test.

*Workpiece should be tested in at least three different places using a diamond penetrator and averaged for a hardness number value (+/- 5 on standard Rockwell C hardness scales).

PERFORMANCE STANDARDS:

- Test given workpieces (samples) for hardness using Rockwell Hardness Test.
- Findings must agree with readings taken by instructor.

SUGGESTED INSTRUCTION TIME: 9 Hours

RELATED TECHNICAL INFORMATION:

- Perform mathematical calculations involving averaging three numbers.
- Explain difference between ferrous and nonferrous alloys.

RELATED TECHNICAL INFORMATION (Con't.):

- Explain difference between machine steel and carbon tool steel.
- Describe effects of underheating and overheating steel.
- Explain how SAE heat treatment numbering system is organized.
- Explain why steel is hardened and tempered.
- Describe procedure for testing hardness of workpiece.
- Explain the Rockwell C hardness scale.
- Identify safety precautions.

UNIT 15.0 HEAT TREATMENT

TASK 15.02 ANNEAL WORKPIECE

PERFORMANCE OBJECTIVE:

Given heat treating equipment, hardened workpiece, specifications, and the necessary tools and materials; anneal the workpiece. The stock must be annealed to specifications of the instructor.

PERFORMANCE ACTIONS:

15.0201 Review specifications, assemble workpiece, and setup heat treating equipment.

15.0202 Place workpiece in heat treatment oven using proper tools and protective equipment.

15.0203 Select and set over temperature from information provided by the instructor or from reference materials.

15.0204 Heat workpiece uniformly to required temperature.

15.0205 Soak workpiece at temperature one hour per inch of thickness.

15.0206 Turn off oven.

15.0207 Allow workpiece to cool in lime container.

15.0208 Remove with tongs and protective equipment. (Next day.)

15.0209 Test workpiece with corner of file.

PERFORMANCE STANDARDS:

- Anneal workpiece according to specifications provided.

SUGGESTED INSTRUCTION TIME: [illegible] hours

RELATED TECHNICAL INFORMATION:

- Define annealing.
- Explain why annealing is performed.
- Identify the proper annealing temperature (oven setting) for various metals (identified by the instructor).
- Describe the procedure for annealing a workpiece.
- Identify safety considerations:
  a. Safety tools and procedures.
  b. Safety clothing, etc.

UNIT 15.0 HEAT TREATMENT

TASK 15.03 (Dual Tasks) HARDEN AND TEMPER A WORKPIECE

PERFORMANCE OBJECTIVE:

Given a furnace for hardening and tempering operations, workpiece(s), quenching solutions, a chart of heat treatment specifications, a hardness testing procedure outlined by the instructor, workbench, file, tongs, and the necessary materials; (a) harden and (b) temper the workpiece(s). The stock must be hardened and temperated to the specifications of the instructor.

PERFORMANCE ACTIONS:

HARDEN PART:

15.0301 Determine proper hardening temperature for type of steel workpiece.

15.0302 Set furnace controls for proper temperature.

15.0303 Using tongs, place part in furnace.

15.0304 Allow part to heat uniformly, not to overheat.

15.0305 Allow part to soak at selected temperature for proper time.

15.0306 Remove part and quench (agitating part in quenching medium). Cool to hand temperature.

15.0307 Clean and test part for hardness with hardness tester.

TEMPER PART: (at once)

15.0308 Using tongs, place hardened workpiece in furnace that has been brought up to the proper temperature.

15.0309 Allow time for workpiece to heat uniformly to tempering temperature. Allow it to soak at this temperature for required time.

15.0310 Remove workpiece from furnace and allow it to cool in still air or by quenching.

15.0311 Determine hardness by testing with a file.

PERFORMANCE STANDARDS:

- Harden and temper a workpiece according to shop (instructor's) standards and procedures using proper references and information to determine temperature used to harden and temper the metal.

SUGGESTED INSTRUCTION TIME: 6 Hours

RELATED TECHNICAL INFORMATION:

- Define:
  a. Hardening
  b. Tempering
- Located in reference material provided, the hardening and tempering temperatures of various alloys.
- Identify the uses of tools that have been tempered to: pale yellow, light straw, dark straw, purple, and purple-blue.
- Describe procedure for hardening workpiece.
- Describe procedure for tempering workpiece.
- Identify safety considerations.

UNIT 15.0 HEAT TREATMENT

TASK 15.04 HARDEN GIVEN SMALL TOOLS

PERFORMANCE OBJECTIVE:

Given heat treatment equipment (torch), necessary tools, materials, and specifications, and small tools such as cold chisels, punches, screwdrivers, etc., that can be hardened in the machine shop; harden the given small tools to the standards of the instructor.

PERFORMANCE ACTIONS: (Actions provided for punch tool.)

15.0401 Heat punch to medium red (about 1 inch from tip) to black (about 2 inches from tip).

15.0402 Cool about half of the red tip by dipping it in clean, cool quinching fluid, until it cools down.

15.0403 Polish punch with a fine abrasive cloth.

15.0404 Observe the color run toward the end as the metal begins to cool. It will be light straw following by dark straw, yellowish brown, purple, violet, and pale blue.

15.0405 When the desired color (violet +/- 400 degrees F) appears at the point, immediately dip the end in the water.

PERFORMANCE STANDARDS:

- Harden given small tools in the machine shop according to the instructor's standards and given information about the metals.

SUGGESTED INSTRUCTION TIME: 3 Hours

UNIT 16.0

THE HYDRAULIC PRESS

MACHINE SHOP
THE HYDRAULIC PRESS
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 16.0	THE HYDRAULIC PRESS	
16.01	Lubricate Hydraulic Press	1/2
16.02	Straighten Parts with Hydraulic Press	1/2
16.03	Set Up, Remove, and Replace Parts with Hydraulic Press	2
	TOTAL HOURS	3

UNIT/TASK	DESCRIPTION
Unit 16.0	THE HYDRAULIC PRESS
16.01	(Lubricate Hydraulic Press) Provided with a hydraulic press, lubricants such as oil and grease, lubricant dispensers, cleaning materials, and required tools; lubricate the hydraulic press. The standards of the instructor or the manufacturer's specifications must be met.
16.02	(Straighten Parts with Hydraulic Press) Given bend metal that can be straightened under pressure, use the hydraulic press to straighten the bent part. The part is to be straightened parallel to the press bed to a tolerance of +/- 1/64 inch.
16.03	(Set Up, Remove, and Replace Parts with Hydraulic Press) Given specifications/drawing, gears, pulley or wheel, a shaft, etc., with keyway, key lubricant, clamps, and measuring instruments; set, remove, and replace parts with press to a tolerance of +/- 1/64 inch.

UNIT 16.0 THE HYDRAULIC PRESS
TASK 16.01 LUBRICATE HYDRAULIC PRESS

PERFORMANCE OBJECTIVE:

Provided with a hydraulic press, lubricants such as oil and grease, lubricant dispensers, cleaning materials, and required tools; lubricate the hydraulic press. The standards of the instructor or the manufacturer's specifications must be met.

PERFORMANCE ACTIONS:

16.0101 Disconnect electrical power to press, if applicable.

16.0102 Locate hydraulic fluid drain plug.

16.0103 Drain fluid into bucket, etc.

16.0104 Locate, remove, and inspect filter, if applicable.

16.0105 Clean or replace filter, if needed.

16.0106 Return filter to press.

16.0107 Replace drain plug.

16.0108 Locate hydraulic fluid fill caps.

16.0109 Replace hydraulic fluid.

16.0110 Lubricate moving parts.

16.0111 Hand lubricate ram.

PERFORMANCE STANDARDS:

- Lubricate hydraulic press to instructor's (manufacturer's) standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

UNIT 16.0 THE HYDRAULIC PRESS

TASK 16.01 LUBRICATE HYDRAULIC PRESS (Con't.)

RELATED TECHNICAL INFORMATION:

- Identify parts of hydraulic press.
- Identify safety considerations in lubricating and cleaning the press:
    - a. Look for hydraulic fluid leaks.
    - b. Check lowering and raising device/cable, etc.
    - c. Examine for bent pins.
    - d. Determine if holes are worn.
    - e. Hydraulic fluid level should be at proper level.

UNIT 16.0 THE HYDRAULIC PRESS

TASK 16.02 STRAIGHTEN PARTS WITH HYDRAULIC PRESS

PERFORMANCE OBJECTIVE:

Given bend metal that can be straightened under pressure, use the hydraulic press to straighten the bent part. The part is to be straightened parallel to the press bed to a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

16.0201 Set up hydraulic press.

16.0202 Place bent part properly/safely in press.

16.0203 Press part to straighten it to a parallel tolerance of +/- 1/64 inch.

PERFORMANCE STANDARDS:

- Straighten parts using the hydraulic press.
- Procedures and product must meet instructor's standards.

SUGGESTED INSTRUCTION TIME: 1/2 Hour

RELATED TECHNICAL INFORMATION:

- Operation of hydraulic press.
- Safety considerations.
- Uses of hydraulic press.

UNIT	16.0	THE HYDRAULIC PRESS
TASK	16.03	SET UP, REMOVE, AND REPLACE PARTS WITH HYDRAULIC PRESS

PERFORMANCE OBJECTIVE:

Given specifications/drawing, gears, pulley or wheel, a shaft, etc., with keyway, key, lubricant, clamps, and measuring instrument; set, remove, and replace parts with press to a tolerance of +/- 1/64 inch.

PERFORMANCE ACTIONS:

SET UP PRESS:

16.0301 Note measurement of position of part to be removed.

16.0302 Place and clamp stationary part to table.

16.0303 Align movable part to ram.

REMOVE PART:

16.0304 Lubricate both part(s).

16.0305 Check disassembly procedures.

16.0306 Apply pressure to remove parts.

16.0307 Check pressure with gauges if applicable.

16.0308 Remove part(s).

REPLACE PART(S):

16.0309 Check assembly procedures.

16.0310 Align parts such as keyways.

16.0311 Lubricate all parts as appropriate.

16.0312 Insert key and press parts together.

16.0313 Check tolerance.

16.0314 Clean press and set up for future use.

PERFORMANCE STANDARDS:

- Set up, remove, and replace parts with hydraulic press meeting the instructor's standards.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

- Cleaning and lubricate hydraulic press.
- Operation of hydraulic press.
- Safety with hydraulic press.

UNIT 17.0

COMPUTER NUMERICALLY CONTROLLED (CNC) MACHINING

In 1983, to introduce secondary machine shop students to the latest, state-of-the-art, hi-tech manufacturing processes, The School District of Greenville County acquired EMCO Compact 5 CNC (Computer Numerically Controlled) Trainers for the three secondary machine shop programs.

As this articulated, instruction objectives guide for machine shop is developed, there has not been adequate time for the CNC instructional objectives described in this unit to have been validated fully.

The objectives described for CNC training probably will need some revisions after the three secondary machine shop instructors have had an opportunity to field trial test the CNC trainers and the tentative objectives described in this unit.

The basic goals of CNC training include:

a. Introducing secondary machine shop students to NC/CNC concepts.
b. Transforming CNC theory into practical applications.
c. Transforming written instruction into CNC operations.
d. Controlling CNC machine operations.
e. Developing skills and knowledges with high transfer to industrial machines with minimum difficulty so students may continue training at the post-secondary level.
f. To orient the students to the fundamentals of CNC organization and peripherial aspects of CNC machining.

This description does NOT represent the NC/CNC training objectives of the post-secondary level program at CTC which uses industrial type equipment.

MACHINE SHOP
CNC MACHINING
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 17.0 CNC MACHINING		
17.01	Identify the Controls and Operations of the Emco Compact 5 CNC Trainer	*
17.02	Identify Program System and Select G-Codes for Machine Operations	*
17.03	Plot CNC Drawing for Coordinates	**
17.04	Calculate Coordinates and Dimensions of CNC Drawing	*
17.05	Write Program for CNC Machine	*
17.06	Set up CNC Program/Machine	*
17.07	Machine Workpiece with CNC Machine	*
	TOTAL HOURS	40

* Continuous training process
** Integrated training

STANDARDS FOR EMCO CNC 5 TRAINER

- Operation of the Emco Compact 5 CNC Trainer will be according to the Student Handbook-Basis or the instructor's handbook.

- Stock material used will be half-hard aluminum.

- Never chuck workpiece without using live centers. Always use the live center of the tailstock as support for a long workpiece. Proper chucking is required.

- Preferably, the student should have demonstrated minimum competencies on hand-operated machines prior to instruction on the CNC trainer: However, the student does not have to be competent in manual machines prior to CNC training.

- Emco Compact 5 CNC training is designed for 3-4 students per machine: However, the instructor will determine the number of students to be assigned to a machine for training.

- The accompanying pages indicate standards of terminology and accessories and tools for the vertical milling drill attachment as well as for the lathe. (See accompanying pages.)

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 17.0	CNC MACHINING
17.01	(Identify the Controls and Operations of the Emco Compact 5 CNC Trainer) Given instruction concerning the EMCO Compact 5 CNC Trainer, BASIS-the handbook for the trainee, an orientation to the trainer, the CNC machine, and all necessary tools and materials; identify the controls and operations of the EMCO Compact 5 CNC Trainer.
17.02	(Identify Program System and Select G-Codes for Machine Operations) Given instruction concerning the CNC trainer and the programming system; identify and select the proper G-Codes to program the desired movements of the CNC trainer.
17.03	(Plot CNC Drawing for Coordinates) Provided with a blueprint-drawing-specifications, CNC machine, student handbook-BASIS, programming tape, and all necessary tools and materials such as graph paper, etc., plot CNC drawing for coordinates for CNC program for a given operation. The program must be to specifications, must correctly operate the CNC machine trainer, and must be acceptable to the instructor.
17.04	(Calculate Coordinates and Dimensions of CNC Drawing) Given blueprint, CNC milling machine, and references; calculate coordinates and dimensions from the blueprint for the CNC machine. Dimensions must meet blueprint specifications with a tolerance of +.- 0.001 inch.
17.05	(Write Program for CNC Machine) Given blueprint-drawing-specifications, CNC machine, tools, workpiece stock, programming forms, student handbook-BASIS, and other necessary materials; write a program to machine the workpiece to specifications using the CNC trainer with a minimum of tool changes, returning to the starting point at the end of the program.
17.06	(Set up CNC Program/Machine) Given instruction, blueprint/drawing/specifications, cutting tools, workpiece, precision measuring instruments, student handbook-BASIS, and the CNC trainer; set up the CNC milling machine for machining a given workpiece. The workpiece must be within a tolerance of +/- 0.001 inch or to specifications.
17.07	(Machine Workpiece with CNC Machine) Given the CNC machine, tools, tool program, work-holding devices, measuring instruments, references, blueprint-drawing-specifications, aluminum stock, and the necessary tools and materials; machine the workpiece to specifications within a tolerance of +/- 0.001 inch of decimal dimensions and +/- 1/64 inch on fraction dimensions.

UNIT 17.0 CNC MACHINING

TASK 17.01 IDENTIFY THE CONTROLS AND OPERATIONS OF THE EMCO COMPACT 5 CNC TRAINER

PERFORMANCE OBJECTIVE:

Given instruction concerning the EMCO Compact 5 CNC Trainer, BASIS-the handbook for the trainee, an orientation to the trainer, the CNC machine, and all necessary tools and materials; identify the controls and operations of the EMCO Compact 5 CNC Trainer.

PERFORMANCE ACTIONS:

17.0101 Pay attention to instructor's introduction of the Emco Compact 5 CNC Trainer.

17.0102 Observe and make notes about operation of machine during orientation. Ask questions.

17.0103 Read and follow the student handbook, BASIS, in developing knowledge and skill in operating the CNC trainer.

PERFORMANCE STANDARDS:

- Identify the controls and operations of the Emco Compact 5 CNC Trainer.
- Performance must be according to procedures identified by the instructor and outlined in the student handbook, BASIS.
- Steps outlined in the student handbook must be followed exactly unless the instructor directs otherwise.

SUGGESTED INSTRUCTION TIME: Integrated

RELATED TECHNICAL INFORMATION:

- Hand operate CNC machine:
  a. Mount toolholder and right hand side tool without setting gage.
  b. Set RPM, speed and traverse slides. Regular feed, Traverse slides in X- and Z-direction.
  c. Set LED display to zero. Switch over display.
  d. Program traverse path.
  e. Calculate cutting values.
  f. Clamp workpiece.
  g. Turn workpiece.
  h. Measure diameters.

RELATED TECHNICAL INFORMATION (Con't.):

- Mount toolholder and position tool.
- Explain:
  a. Longitudinal or cross slide.
  b. Traverse of slide.
  c. Direction rate.
  d. Feed rate.
- Explain minus value.
- Explain "coding."

UNIT	17.0	CNC MACHINING
TASK	17.02	IDENTIFY PROGRAM SYSTEM AND SELECT G-CODES FOR MACHINE OPERATIONS

PERFORMANCE OBJECTIVE:

Given instruction concerning the CNC trainer and the programming system; identify and select the proper G-Codes to program the desired movements of the CNC trainer.

PERFORMANCE ACTIONS:

17.0201 Describe the programming system of the Emco Compact 5 CNC Trainer: N, G, X, Z, F

17.0202 Select the proper G-Codes for required machine operations:

Program system: N, G, X, Z, F

N = Block numbers 00-95
G = Preparatory command
  00 = Rapid traverse
  01 = Long, turning, facing and taper turning
  02 + 03 = Circular interpolation (spherical turning)
  20 = Programmed stop
  21 = No operation block
  22 = Program stop
  33 = Thread cutting
  64 = Feed motors without current supply
  65 = Magnetic tape memory
  78 = Thread cutting cycle
  84 = Turning cycle
X + Z = Input step for longitudinal movement in 0.01 mm
F = Feed rate input and pitch in 0.01 mm

PERFORMANCE STANDARDS:

- Identify the program system and select G-Codes for CNC trainer machining operations.
- Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT	17.0	CNC MACHINING
TASK	17.02	IDENTIFY PROGRAM SYSTEM AND SELECT G-CODES FOR MACHINE OPERATIONS (Con't.)

RELATED TECHNICAL INFORMATION:

- Student Handbook-BASIS.
- Orientation to CNC Trainer programming.

UNIT 17.0 CNC MACHINING

TASK 17.03 PLOT CNC DRAWING FOR COORDINATES

PERFORMANCE OBJECTIVE:

Provided with a blueprint-drawing-specifications, CNC machine, student handbook-BASIS, programming tape, and all necessary tools and materials such as graph paper, etc.; plot drawing for coordinates for CNC program for a given operation. The program must be to specifications, must correctly operate the CNC machine trainer, and must be acceptable to the instructor.

PERFORMANCE ACTIONS:

17.0301 Review blueprint-drawing-specifications.

17.0302 Review student handbook, BASIS.

17.0303 Determine the sequence of operations:

a. Determine operations required.
b. Determine tools required.

17.0304 Establish reference points (starting and finishing).

17.0305 Calculate required dimensions.

17.0306 Determine tool changes.

17.0307 Write program on program sheet:

a. Note tool changes.
b. Note other instructions.

17.0308 Check program.

17.0309 Enter program in machine.

17.0310 Execute operation to check program.

17.0311 Make measurements and make corrections as necessary.

PERFORMANCE STANDARDS:

- Plot drawing for CNC program coordinates.
- Taped program must be to specifications, must correctly operated the CNC trainer, and must be acceptable to the instructor.

UNIT 17.0 CNC MACHINING

TASK 17.03 PLOT CNC DRAWING FOR COORDINATES (Con't.)

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Use of graph paper.
- Drawing workpiece.
- Measuring.
- Use of 1:10 scale for technical drawing.
- Identify G-codes.

UNIT 17.0 CNC MACHINING

TASK 17.04 CALCULATE COORDINATES FOR DIMENSIONS OF CNC DRAWING

PERFORMANCE OBJECTIVE:

Given blueprint, CNC milling machine, and references; calculate coordinates and dimensions from the blueprint for the CNC machine. Dimensions must meet blueprint specifications with a tolerance of +/- 0.001 inch.

PERFORMANCE ACTIONS:

17.0401 Identify type of spindle positioning:

a. Determine incremental measurement or,
b. Absolute or coordinate measurement.

17.0402 Interpret blueprint data to:

a. Check number of holes same size.
b. Check number of holes requiring same operation.

17.0403 Establish starting of absolute zero point:

a. Corner of workpiece.
b. Off workpiece for tool changes.

17.0404 Convert all dimensions including angles to decimal dimensions.

17.0405 Calculate dimensions from two adjacent sides as from point zero.

17.0406 Verify calculations as within tolerance by adding plus (+) and (-) dimensions in each axis.

17.0407 Check calculations, correcting any error until tolerance is obtained.

PERFORMANCE STANDARDS:

- Calculate coordinates and dimensions of CNC drawing within a tolerance of +/- 0.001 inch.
- Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Integrated training

(NOTE: This task is jointly conducted with the previously described and following tasks.)

UNIT 17.0 CNC MACHINING

TASK 17.05 WRITE PROGRAM FOR CNC MACHINE

PERFORMANCE OBJECTIVE:

Given blueprint-drawing-specifications, CNC machine, tools, workpiece stock, programming forms, student handbook-BASIS, and other necessary materials; write a program to machine the workpiece to specifications using the CNC trainer with a minimum of tool changes, returning to the starting point at the end of the program.

PERFORMANCE ACTIONS:

17.0501 Review blueprint-drawing-specifications.

17.0502 Review student handbook, BASIS.

17.0503 Determine machine set-up requirements.

17.0504 Determine sequence of operations:

a. Determine operations to be performed.
b. Determine order of operations: Plunge, turn, thread, part, mill, drill, etc.

17.0505 Determine tools required.

17.0506 Establish starting and finishing reference points.

17.0507 Calculate dimensions not on blueprint.

17.0508 Determine tool changes.

17.0509 Write program:

a. Note tool changes.
b. Note other instructions.

17.0510 Verify program:

a. Plus values and minus values of (x) equals zero.
b. Plus values and minus values of (z) equals zero.

UNIT 17.0 CNC MACHINING

TASK 17.05 WRITE PROGRAM FOR CNC MACHINE (Con't.)

PERFORMANCE STANDARDS:

- Write program for CNC machine operations to produce workpiece to given specifications using a minimum of tool changes, returning to the starting point at the end of the program.

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- BASIS handbook for students.

UNIT 17.0 CNC MACHINING

TASK 17.06 SET UP CNC PROGRAM/MACHINE

PERFORMANCE OBJECTIVE:

Given instruction, blueprint-drawing-specifications, cutting tools, workpiece, precision measuring instruments, student handbook-BASIS, and the CNC trainer; set up the CNC milling machine for machining a given workpiece. The workpiece must be within a tolerance of +/- 0.001 inch or to specifications.

PERFORMANCE ACTIONS:

17.0601 a. Review print-drawing-specifications.
b. Review operator's manual (BASIS).

17.0602 Mount workpiece.

17.0603 Center spindle.

17.0604 Place tape in tape reader.

17.0605 Mount tool in toolholder.

17.0606 Input program.

17.0607 Check program: Make necessary corrections

a. Turn first workpiece.
b. Measure.
c. Switch over to hand-operation.
d. Correct starting point.
e. Second workpiece will be true to measure.

17.0608 Manufacturer workpiece: Change tools as necessary.

17.0609 Measure workpiece for tolerances.

PERFORMANCE STANDARDS:

- Set up the CNC program/machine for a given manufacturing operation.
- Procedures must be according to manufacturer's instruction handbook.
- Process and product must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Identify type of slide: Longitudinal or cross slide (x & z).
- Identify traverse of slide.
- Identify direction.
- Identify feed rate.
- Explain the right hand coordinate system rule.
- Identify 2 types of feed.
- Explain the G-functions in programming the CNC machine.
- Describe rapid transverse (No F-programming).
- Describe what measure to take with alarm or false input (switch off main, start from beginning). [Attention to collision! Use of emergency-stop-button. Use of main power switch.]
- Prepare proper technical drawing to scale of 1:10 on graph paper to prevent errors in measuring, programming.

UNIT 17.0 CNC MACHINING

TASK 17.07 MACHINE WORKPIECE WITH CNC MACHINE

PERFORMANCE OBJECTIVE:

Given the CNC machine, tools, tool program, work-holding devices, measuring instruments, references, blueprint-drawing-specifications, aluminum stock, and the necessary tools and materials; machine the workpiece to specifications within a tolerance of +/- 0.001 inch of decimal dimensions and +/- 1/64 inch on fraction dimensions.

PERFORMANCE ACTIONS:

17.0701 Review operating instructions.

17.0702 Review blueprint-drawing-specifications.

17.0703 Review tool program OR set up program.

17.0704 Check tools.

17.0705 Mount workpiece in work-holding device.

17.0706 Mount tool.

17.0707 a. Manually operate machine OR,
b. Place tape in reader and start reader.

17.0708 Machine workpiece: Check program and make necessary corrections

17.0709 a. Monitor for tool changes.
b. Monitor for depth stops.
c. Monitor for other required changes.

17.0710 Remove finished workpiece and deburr.

17.0711 Verify tolerance of workpiece.

PERFORMANCE STANDARDS:

- Machine a workpiece on the CNC machine to specifications within a tolerance of +/- 0.001 inch on decimal dimensions and +/- 1/64 inch on fraction dimensions.
- The proper procedures of operation must be followed.
- A program entered on tape must be verified as correct.
- Performance and product must be to the instructor's standards.

UNIT 17.0 CNC MACHINING

TASK 17.07 MACHINE WORKPIECE WITH CNC MACHINE (Con't.)

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Identify operation and control elements of the CNC machine.
- Hand operate CNC machine.
- Describe/demonstrate how to correct measurements in drawing if raw material (stock) has different dimensions.
- Calculate cutting values.
- Describe/demonstrate how to clamp workpiece (mount workpiece).
- Demonstrate how to turn workpiece, measure workpiece, and correct diameter.
- Demonstrate how to position the tool.

UNIT 18.0

MACHINING MATH CALCULATIONS

The math calculations summarized in this unit represent mathematical skills that the student should master by the latter part of the second year of training.

The math calculation skills described in this unit may be developed during the first or second year of learning and may be associated with related machining operations rather than being learned as stand-alone tasks.

MACHINE SHOP
MACHINING MATH CALCULATIONS
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 18.0	MACHINING MATH CALCULATIONS	
18.01	Calculate Amount of Stock Required for Machining Job	*
18.02	Convert Revolutions Per Minute or Grinding Wheel to Surface Feet Per Minute	*
18.03	Calculate Depths and Widths of Slots and Grooves on Special Setups	*
18.04	Calculate Feeds and Speeds	*
18.05	Calculate for Angular and Simple Indexing	*
18.06	Calculate Gear Blank Specifications	*
18.07	Calculate Sine-Bar Dimensions for Machine Shop	*
18.08	Calculate Tap Drill Size with Formula	*
18.09	Calculate Taper for Machine Shop	*
18.10	Calculate Tolerance/Allowances	*
18.11	Convert Common Fractions to Decimal Fractions	*
18.12	Convert Dimensions to Metric Size	*
	TOTAL HOURS	40

* Integrated training

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 18.0	MACHINING MATH CALCULATIONS
18.01	(Calculate Amount of Stock Required for Machining Job) Given a blueprint for a machining job, calipers, gages, rules, tapes, etc., and an inventory of stock material; calculate and record the stock required to perform the job specified on the blueprint. Maximum use should be made of scrap stock. The material to be used must be accurately estimated and recorded on the form required by the instructor.
18.02	(Convert Revolutions Per Minute or Grinding Wheel to Surface Feet Per Minute) Given reference material, calculate surface feet per minute (SFPM) of a grinding wheel. Round off answer to decimal point. Answer must be within 5 SFPM and maximum speed must not exceed handbook specifications.
18.03	(Calculate Depths and Widths of Slots and Grooves on Special Setups) Given blueprint references, and workpiece, calculate dimensions of slots and grooves for special setup. A tolerance of +/- 0.001 inch must be obtained in calculations.
18.04	(Calculate Feeds and Speeds) Given blueprint, workpiece and machinery specifications, milling machine, milling cutter, measuring instruments; calculate speed and feed. Speed must be within a tolerance of +/- 5 RPM and feed within a tolerance of +/- 0.001 inch.
18.05	(Calculate for Angular and Simple Indexing) Given a blueprint, reference material, workpiece, indexing head, indexing plates, and Machinery's Handbook; calculate indexing dimensions. Simple indexing dimensions must be within a tolerance of +/- 5 minutes.
18.06	(Calculate Gear Blank Specifications) Given blueprint, workpiece, reference material such as the Machinery's Handbook, gear blank, and gear tables; calculate gear (blank) specifications. Calculations must be to an accuracy of +/- 0.001 inch.
18.07	(Calculate Sine-Bar Dimensions for Machine Shop) Given workpiece, blueprint and precision measuring equipment, sine-bar, gage blocks, vernier micrometer caliper, Machinery's Handbook; calculate dimensions required to set up the workpiece for machining an angle. The dimensions must be within a tolerance of +/- .0005 inch.

18.08 (Calculate Tap Drill Size with Formula) Provided with a blueprint, workpiece, and reference material; calculate tap drill size. The calculations must match by 100 percent tap drill chart for 80 percent thread depth.

18.09 (Calculate Tapers for Machine Setup) Given blueprint, workpiece, and Machinery's Handbook, calculate the dimensions required for machining the workpiece. The dimensions must be within a tolerance of +/- 0.001 inch on decimal dimensions, +/- 1/64 inch on fraction dimensions, and +/- 5 minutes on angular dimensions.

18.10 (Calculate Tolerance/Allowances) Given a workpiece, blueprint, and reference; calculate tolerance/allowance for specific job to a bilateral tolerance of +/- 0.001 inch.

18.11 (Convert Common Fractions to Decimal Fractions) Given blueprint, convert fraction dimensions to decimal dimensions with an accuracy of +/- 0.001 inch.

18.12 (Convert Dimensions to Metric Size) Given blueprint and references, convert dimensions on blueprint to metric equivalent. Dimensions must be within a tolerance of +/- 1/100th mm.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.01 CALCULATE AMOUNT OF STOCK REQUIRED FOR MACHINING JOB

PERFORMANCE OBJECTIVE:

Given a blueprint for a machining job, calipers, gages, rules, tapes, etc., and an inventory of stock material; calculate and record the stock required to perform the job specified on the blueprint. Maximum use should be made of scrap stock. The material to be used must be accurately estimated and recorded on the form required by the instructor.

PERFORMANCE ACTIONS:

18.0101 Review the blueprint:

- a. Check finished stock size.
- b. Check material required.

18.0102 Check scrap stock:

- a. Select and measure available stock.
- b. Consider work-holding device.
- c. Consider machining operation(s).

18.0103 Complete description of material needed.

PERFORMANCE STANDARDS:

- Calculate amount of stock required for machining job to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: Integrated training

POSSIBLE FORM FORMAT:

STOCK REQUIRED FOR JOB

STUDENT ______________________ JOB/PROJECT # ______________

CLASS ______________________ DATE ______________

Material Description	Kind Material	Shape	Size

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.02 CONVERT REVOLUTIONS PER MINUTE OR GRINDING WHEEL TO SURFACE FEET PER MINUTE

PERFORMANCE OBJECTIVE:

Given reference material, calculate surface feet per minute (SFPM) of a grinding wheel. Round off answer to decimal point. Answer must be within 5 SFPM and maximum speed must not exceed handbook specifications.

PERFORMANCE ACTIONS:

18.0201 Check grinding wheel diameter.

18.0202 Check grinding wheel for maximum speed noted.

18.0203 Check speed of grinder.

18.0204 Calculate surface feed per minute (SFPM) using the formula:

$$\text{SFPM} = \text{RPM} \times D/12 \times \pi$$

Where

RPM = revolutions per minute
SFPM = surface feet per minute

D = diameter of wheel in inches
π = 3.14

x = multiplication sign

18.0205 Check maximum speed in Machinery's Handbook to ensure calculated speed is within handbook specifications.

PERFORMANCE STANDARDS:

- Convert revolutions per minute of grinding wheel to surface feet per minute, rounding off the answer to the decimal point, and not exceeding the maximum speed recommended in the Machinery's Handbook.

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.03 CALCULATE DEPTHS AND WIDTHS OF SLOTS AND GROOVES ON SPECIAL SETUPS

PERFORMANCE OBJECTIVE:

Given blueprint references, and workpiece, calculate dimensions of slots and grooves for special setup. A tolerance of +/- 0.001 inch must be obtained in calculations.

PERFORMANCE ACTIONS:

18.0301 Review blueprint.

18.0302 Determine dimensions needed for machining workpiece.

18.0303 Check machinist's handbook for table or formula.

18.0304 Calculate required dimensions and round off answer to nearest 0.001 inch.

18.0305 Repeat above steps and check answer.

PERFORMANCE STANDARDS:

- Calculate depths and widths of slots and grooves on special setups to a tolerance of +/- 0.001 inch in calculations.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.04 CALCULATE FEEDS AND SPEEDS

PERFORMANCE OBJECTIVE:

Given blueprint, workpiece, and machinery specifications, milling machine, milling cutter, measuring instruments; calculate speed and feed. Speed must be within a tolerance of +/- 5 RPM and feed within a tolerance of +/- 0.001 inch.

PERFORMANCE ACTIONS:

18.0401 Interpret blueprint.

18.0402 Measure workpiece.

18.0403 Determine machining specifications:

- a. Amount of stock to be removed.
- b. Number of cuts.
- c. Required finish.
- d. Workpiece material.
- e. Cutter material and size.
- f. Size of workpiece.
- g. Determine depth of cut.

18.0404 Calculate speed of machine:

- a. Check formula in Machinery's Handbook.
- b. Round off to whole number.

18.0405 Calculate feed or workpiece:

- a. Refer to Machinery's Handbook.
- b. Round off to nearest thousandth of an inch.

18.0406 Verify calculations as within tolerance of 0.001 inch.

PERFORMANCE STANDARDS:

- Calculate feeds and speeds for given situations with a tolerance of +/- 5 RPM for speed and +/- 0.001 inch for feed.

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.05 CALCULATE FOR ANGULAR AND SIMPLE INDEXING

PERFORMANCE OBJECTIVE:

Given a blueprint, reference material, workpiece, indexing head, indexing plates, and Machinery's Handbook; calculate indexing dimensions. Simple indexing dimensions must be within a tolerance of +/- 5 minutes.

PERFORMANCE ACTIONS:

18.0501 Review blueprint.

18.0502 Note index head and index plates available.

18.0503 Calculate simple indexing movement:

a. Refer to Machinery's Handbook.
b. Use formula to obtain simple indexing movement:

$$\frac{40}{\text{No. of Divisions}} = \text{No. of Turns}$$

c. For partial (fractional) turns reduce or increase fraction until denominator equals number of holes in index plate:

(e.g., $\frac{3}{7} = \frac{3}{7} \times \frac{3}{3} = \frac{9}{21}$ [index plate no.]

d. Use table to check calculations.

18.0504 Calculate angular indexing dimensions:

a. One full turn on index head equals 9 degrees.
b. Calculate number of full turns for each 9 degrees required.
c. Select index plate with hole circle divisible by 9 for degrees less than 9.
d. Divide hole circle by 9 to find number of holes for each degree.
e. For angular indexing minutes, convert degrees to minutes using the formula:

$$\frac{\text{Minutes required}}{540} = \text{Angular indexing minutes where degrees are converted to minutes}$$

PERFORMANCE ACTIONS (Con't.):

18.0505 Verify calculations with tables in Machinery's Handbook.

PERFORMANCE STANDARDS:

- Calculate for angular and simple indexing to a tolerance of +/- 5 minutes.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.06 CALCULATE GEAR BLANK SPECIFICATIONS

PERFORMANCE OBJECTIVE:

Given blueprint, workpiece, reference material such as the Machinery's Handbook, gear blank, and gear tables; calculate gear (blank) specifications. Calculations must be to an accuracy of +/- 0.001 inches.

PERFORMANCE ACTIONS:

18.0601 Review blueprint.

18.0602 Determine diametrical pitch and number of teeth.

18.0603 Calculate outside diameter of gear blank:

a. $OD = \frac{N+2}{P}$

Where
OD = outside diameter
N = number of teeth
P = diametrical pitch

b. Check answer with table of Handbook.

18.0604 Calculate depth of tooth:

a. Use formula:
$d = \frac{2.157}{P}$

Where
d = depth of tooth
p = diametrical pitch

b. Check answer with table, Handbook, or cutter.

18.0605 Calculate tooth thickness:

a. Use formula:

$t = \frac{1.5108}{P}$

Where
t = tooth thickness
p = diametrical pitch

PERFORMANCE ACTIONS (Con't.):

b. Calculate addendum using formula:

$$a = \frac{1.0}{p}$$

Where
a = addendum
p = diametrical pitch

18.0606 Calculate chordal addendum using formula:

$$ca = a + \frac{t2}{4D}$$

Where
ca = chordal addendum
a = addendum
t = tooth thickness
D = outside diameter

18.0607 Calculate chordal thickness:

a. Use formula:

$$ct = D \sin \frac{(90)}{N}$$

Where
ct = chordal thickness
D = outside diameter
N = number of teeth

b. Verify answers in Machinery's Handbook or tables.

18.0608 Check calculations for allowed tolerance.

PERFORMANCE STANDARDS:

- Calculate gear blank specifications that are accurate to +/- 0.001 inch.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.07 CALCULATE SINE-BAR DIMENSIONS FOR MACHINE SHOP

PERFORMANCE OBJECTIVE:

Given workpiece, blueprint, and precision measuring equipment, sine-bar, gage blocks, vernier micrometer caliper, Machinery's Handbook; calculate dimensions required to set up the workpiece for machining an angle. The dimensions must be within a tolerance of +/- .0005 inch.

PERFORMANCE ACTIONS:

18.0701 Review blueprint.

18.0702 Note angle require.

18.0703 Select sine-bar.

18.0704 Obtain sine or angle from table.

18.0705 Multiple sine of angle by length of sine-bar for dimension.

18.0706 Verify answer with sine-bar table in Machinery's Handbook.

PERFORMANCE STANDARDS:

- Calculate sine-bar dimensions for machine setup with an accuracy of +/- .0005 inch.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.08 CALCULATE TAP DRILL SIZE WITH FORMULA*

PERFORMANCE OBJECTIVE:

Provided with a blueprint, workpiece, and reference material; calculate tap drill size. The calculations must match by 100 percent tap drill chart for 80 percent thread depth.

PERFORMANCE ACTIONS:

18.0801 Review blueprint for threaded hole size.

18.0802 Calculate tap drill size:

a. Use formula:

$$\text{Hole size} = \frac{.0129 \times \%\ \text{thread}}{\text{thread per inch}}$$

b. Round off answer to nearest 1/1000th (.001) inch.

18.0803 Select tap drill:

a. Check letter, number and fraction charts for decimal equivalents.
b. Select drill nearest to calculations.

PERFORMANCE STANDARDS:

- Calculate tap drill size with formula with 100 percent accuracy for tap drill chart and 80 percent for thread depth.

SUGGESTED INSTRUCTION TIME: Integrated training

*Alternate task: Use drill chart.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.09 CALCULATE TAPERS FOR MACHINE SETUP

PERFORMANCE OBJECTIVE:

Given blueprint, workpiece, and Machinery's Handbook; calculate the dimensions required for machining the workpiece. The dimensions must be within a tolerance of +/- 0.001 inch on decimal dimensions, +/- 1/64 inch on fraction dimensions, and +/- 5 minutes on angular dimensions.

PERFORMANCE ACTIONS:

18.0901 Study blueprint.

18.0902 Determine dimensions defining taper.

18.0903 Calculate taper per inch using formula:

a. Small diameter, larger diameter, and given length, using formula:

$$T = \frac{(D-d)}{L}$$

Where

T = taper per inch
D = large diameter in inches
d = small diameter in inches
L = length of taper in inches

b. To obtain taper per foot multiply (T) by 12.

c. When small diameter, large diameter, and length of taper are given, but overall length is longer than taper use the formula:

$$\text{tpf} = \frac{\text{large diameter} - \text{small diameter}}{\text{length of taper (inches)}} \times 12$$

d. Calculate tailstock offset using the formula:

$$\text{Offset} = \frac{\text{tpf} \times \text{total length (inches)}}{24}$$

18.0904 Verify calculations with Machinery's Handbook.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.09 CALCULATE TAPERS FOR MACHINE SETUP (Con't.)

PERFORMANCE STANDARDS:

- Calculate tapers for machine setup.
- Dimensions must be within a tolerance of +/- .001 inches on decimal dimensions, +/- 1/64 inches on fractions dimensions, and +/- 5 minutes on angular dimensions.

SUGGESTED INSTRUCTION TIME: Integrated training

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.10 CALCULATE TOLERANCE/ALLOWANCES

PERFORMANCE OBJECTIVE:

Given a workpiece, blueprint, and references; calculate tolerance/allowance for specific job to a bilateral tolerance of +/- 0.001 inches.

PERFORMANCE ACTIONS:

18.1001 Review blueprint:

- a. Note fit required.
- b. Note tolerance of mating part.
- c. Note tolerance in references* for desired fit.
- d. Note nominal diameter.

18.1002 Calculate bilateral tolerance with formula:

- a. Maximum size of mating part plus maximum tolerance (for desired fit) of mating part = upper limit of workpiece dimension.
- b. Minimum size of mating part minus minimum tolerance (for desired fit) of mating part = lower limit of workpiece dimensions.
- c. Upper limit minus lower unit = total allowance of workpiece.
- d. $\frac{\text{Total allowance of workpiece}}{}$ = bilateral tolerance.

18.1003 Verify calculations.

PERFORMANCE STANDARDS:

- Calculate tolerance/allowance for specific job to a bilateral tolerance of +/- 0.001 inch.

SUGGESTED INSTRUCTION TIME: Integrated training

*Machinery's Handbook

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.11 CONVERT COMMON FRACTIONS TO DECIMAL FRACTIONS

PERFORMANCE OBJECTIVE:

Given blueprint, convert fraction dimensions to decimal dimensions with an accuracy of +/- 0.001 inch.

PERFORMANCE ACTIONS:

18.1101 Note fraction part of dimension.

18.1102 Divide numerator of fraction by denominator of fraction.

18.1103 Round answer off to nearest .001 inch.

18.1104 Verify answer by placing number of 100 and reducing.

18.1105 Verify answer with decimal equivalent chart.

PERFORMANCE STANDARDS:

- Convert common fractions to decimal fractions.

SUGGESTED INSTRUCTION TIME: Integrated training

RELATED TECHNICAL INFORMATION:

- Machinery's Handbook.

UNIT 18.0 MACHINING MATH CALCULATIONS

TASK 18.12 CONVERT DIMENSIONS TO METRIC SIZE

PERFORMANCE OBJECTIVE:

Given blueprint and references, convert dimensions on blueprint to metric equivalent. Dimensions must be within a tolerance of +/- 1/100th mm.

PERFORMANCE ACTIONS:

18.1201 Note dimension on blueprint.

18.1202 Convert dimension to metric size:

- a. On decimal dimensions multiply by 25.4 and find millimeters (include whole number).
- b. Convert fractions to decimal fraction and multiply by 25.4 to find millimeters (include whole number).

18.1203 Verify answer with conversion chart.

PERFORMANCE STANDARDS:

- Convert dimensions to metric size within a tolerance of +/- 1/100th mm.

SUGGESTED INSTRUCTION TIME: Integrated training

LEARNING PROJECTS
SECOND YEAR

Machining projects used during the second year of secondary training are designed to strengthen those competencies mastered during the first year of training and to develop new skills.

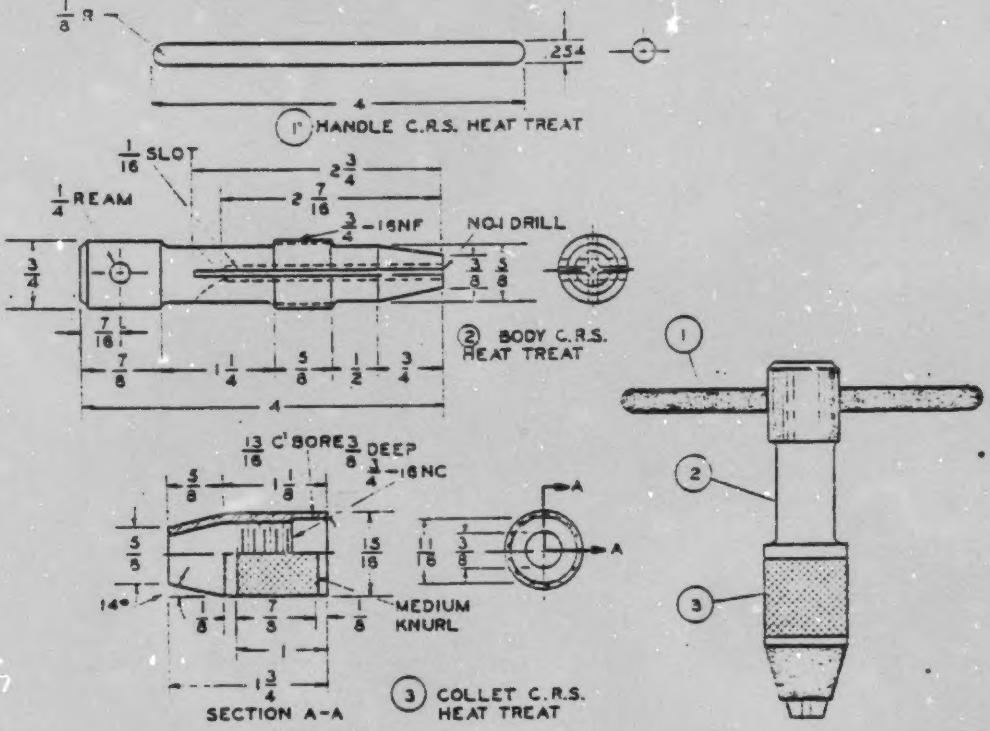
Learning projects during the second year may include machining jobs for other vocational programs, the School District, students, or faculty. (See description of Learning Projects, First Year.)

Typical second year machine shop projects include machining the following:

- Sine Bar
- "T" Handle
- Tap Handle
- Arbor Press
- Vise
- Possibly a Gyroscope or other more difficult machining job

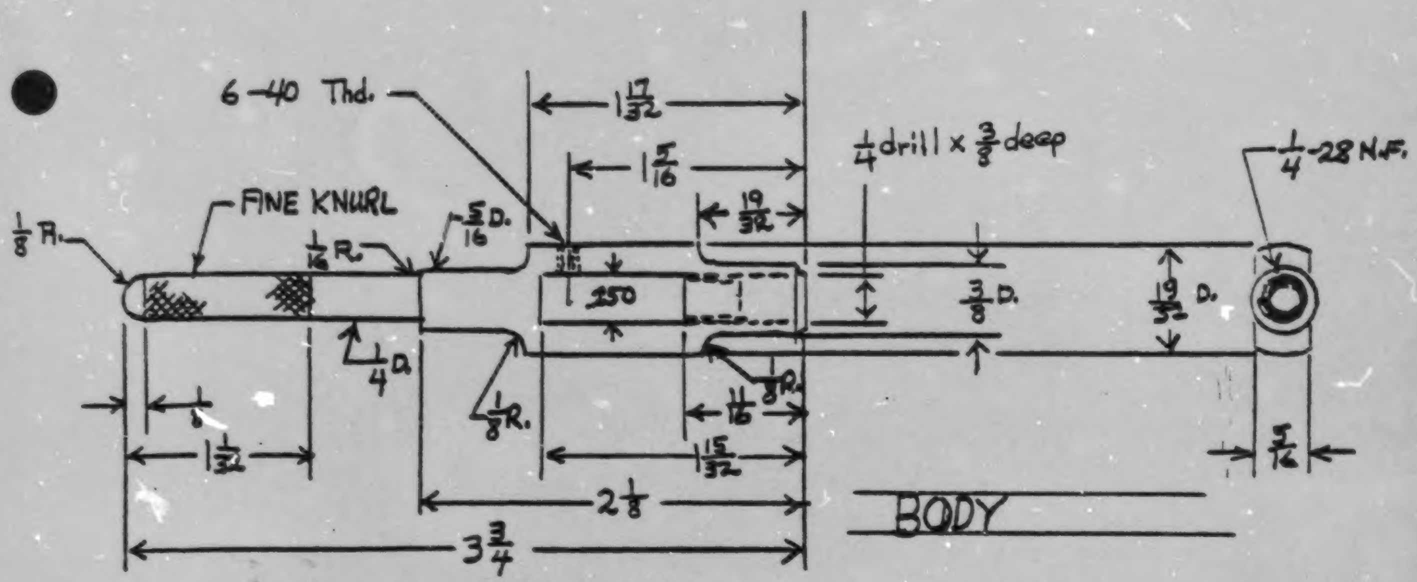
One program has manufactured clocks which incorporated a number of machining tasks.

INSTRUCTION TIME PLANNED FOR
SECOND YEAR LEARNING PROJECTS: 199 Hours
(Approximately 66 days = 13 weeks)


1/8 R
.254
4
1 HANDLE C.R.S. HEAT TREAT
1/16 SLOT
2 3/4
1/4 REAM
2 7/16
3/4-16NF
NO-1 DRILL
3/4
3/8
5/8
7/16
7/8
1 1/4
5/8
1/2
3/4
4
2 BODY C.R.S. HEAT TREAT
13/16 C'BORE 3/8 DEEP
3/4-16NC
5/8
1 1/8
5/8
15/16
11/16
3/8
A
A
14°
1/8
7/8
1/8
MEDIUM KNURL
1
1 3/4
SECTION A-A
3 COLLET C.R.S. HEAT TREAT
1
2
3

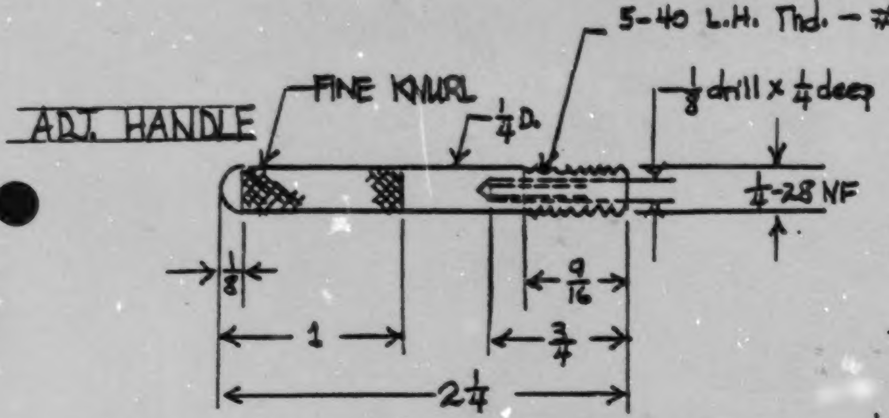
T-tap wrench.

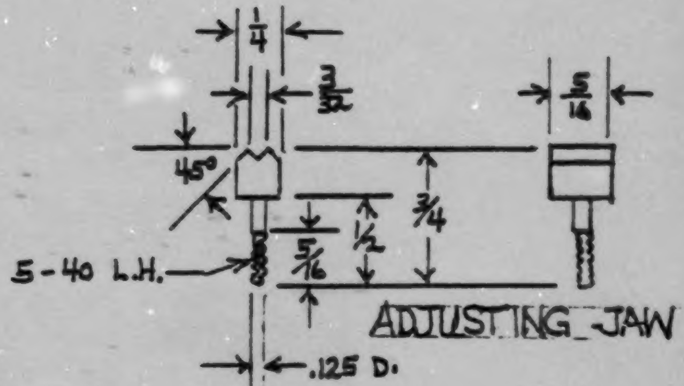
No. 00 TAP HANDLE


6-40 Thd.
$1\frac{17}{32}$
$1\frac{5}{16}$
$\frac{19}{32}$
$\frac{1}{4}$ drill × $\frac{3}{8}$ deep
$\frac{1}{4}$-28 N.F.
$\frac{1}{8}$ R.
FINE KNURL
$\frac{1}{16}$ R.
$\frac{5}{16}$ D.
$\frac{1}{16}$
.250
$\frac{3}{8}$ D.
$\frac{19}{32}$ D.
$\frac{1}{4}$ D.
$\frac{1}{8}$ R.
$\frac{1}{8}$ R.
$\frac{11}{16}$
$\frac{1}{8}$
$1\frac{1}{32}$
$1\frac{15}{32}$
$\frac{5}{16}$
$2\frac{1}{8}$
$3\frac{3}{4}$

BODY

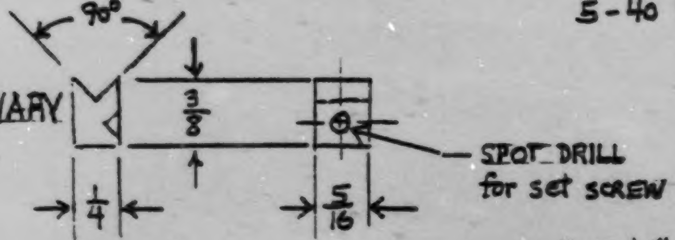
ADJ. HANDLE

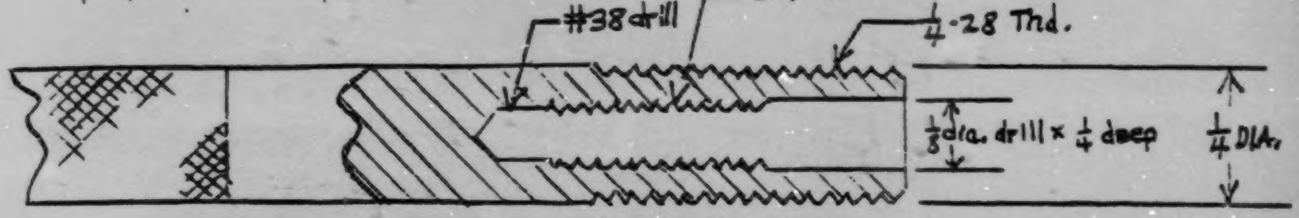

5-40 L.H. Thd. – #38 TAP DRILL
FINE KNURL
$\frac{1}{4}$ D.
$\frac{1}{8}$ drill × $\frac{1}{4}$ deep
$\frac{1}{4}$-28 NF
$\frac{1}{8}$
$\frac{9}{16}$
1
$\frac{3}{4}$
$2\frac{1}{4}$


$\frac{1}{4}$
$\frac{3}{32}$
$\frac{5}{16}$
45°
$\frac{3}{4}$
$\frac{1}{2}$
$\frac{5}{16}$
5-40 L.H.
.125 D.

ADJUSTING JAW

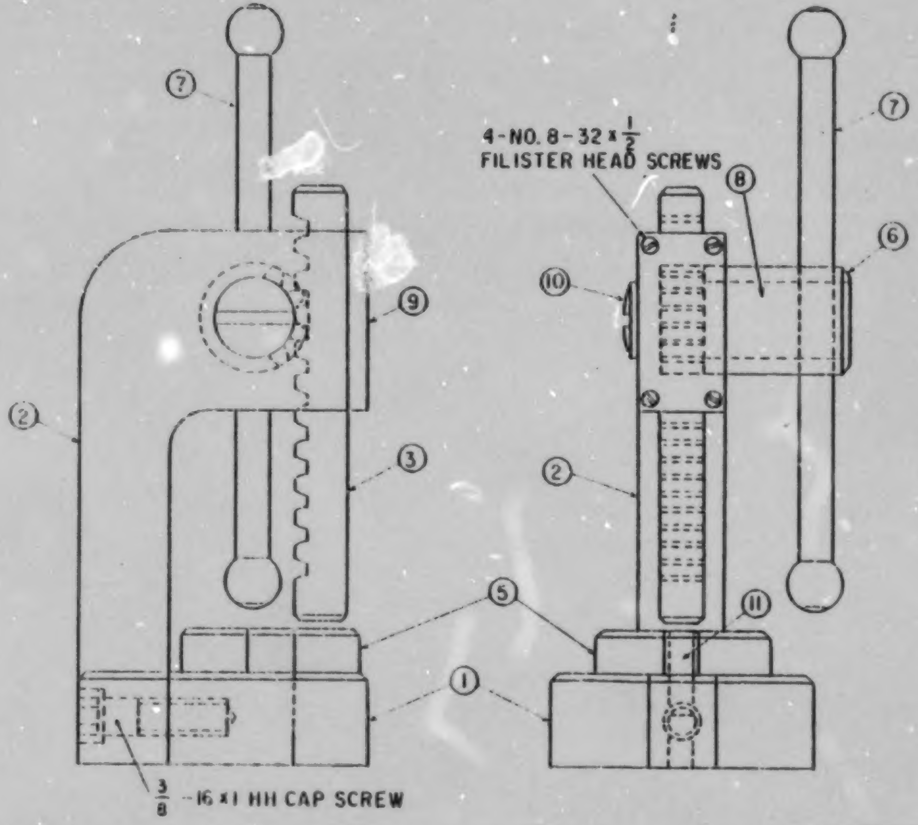
STATIONARY JAW


90°
$\frac{3}{8}$
$\frac{1}{4}$
$\frac{5}{16}$
SPOT DRILL for set screw


#38 drill
5-40 LH Thd.
$\frac{1}{4}$-28 Thd.
$\frac{1}{8}$ dia. drill × $\frac{1}{4}$ deep
$\frac{1}{4}$ DIA.

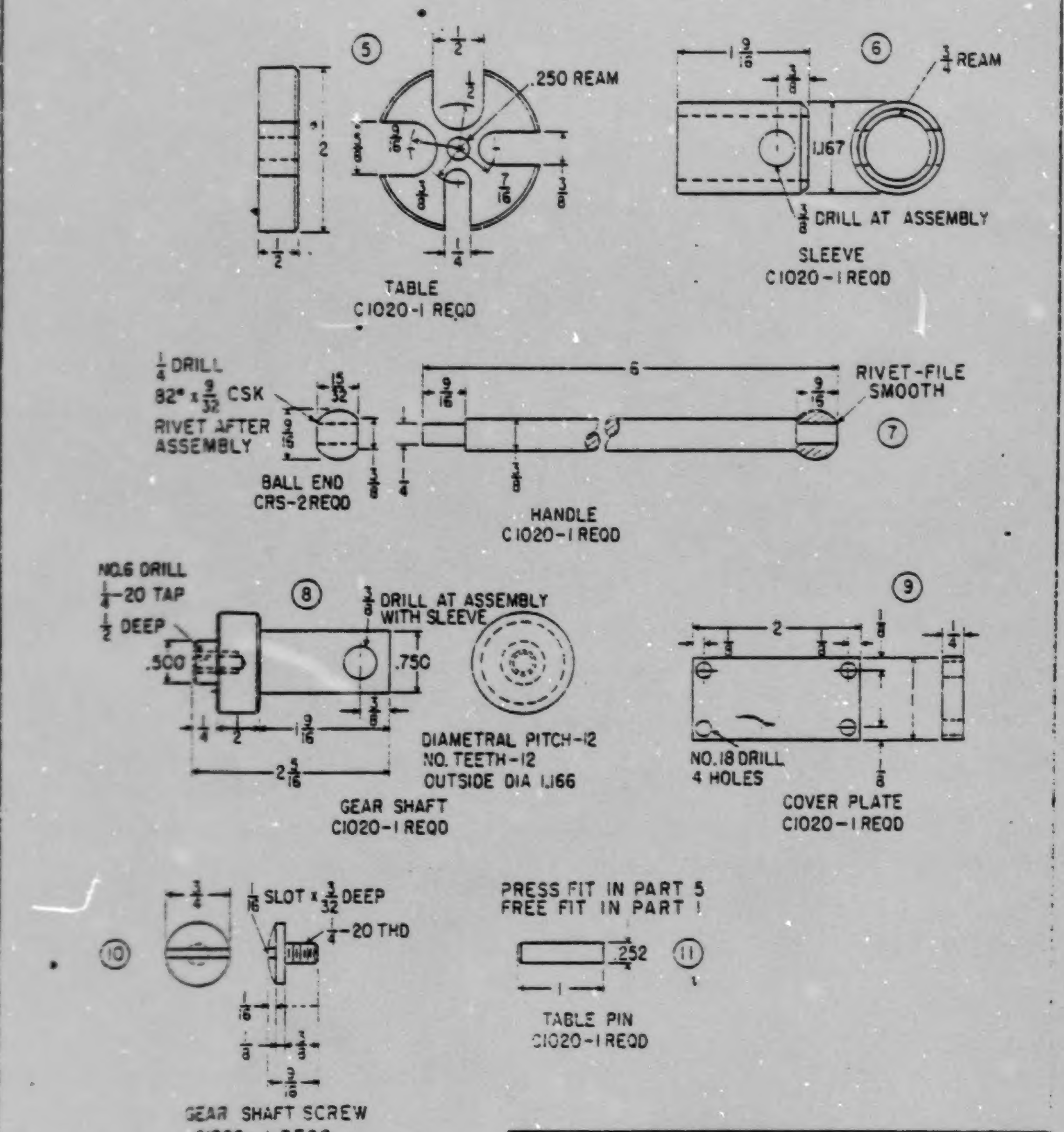
3 TIMES SCALE VIEW OF THD. DETAIL OF ADJUSTING HDLE

460-C


⑦
⑨
②
③
⑤
①
3/8 -16 x 1 HH CAP SCREW
4-NO. 8-32 x 1/2
FILISTER HEAD SCREWS
⑧
⑦
⑥
⑩
②
⑪
⑤
①

DO NOT SCALE DWG. — WORK TO FIGURES.
TOLERANCES: — UNLESS OTHERWISE SPECIFIED
DEC DIMS. ±.005 FRAC DIMS. ±1/64 ANGULAR DIMS. ±1°

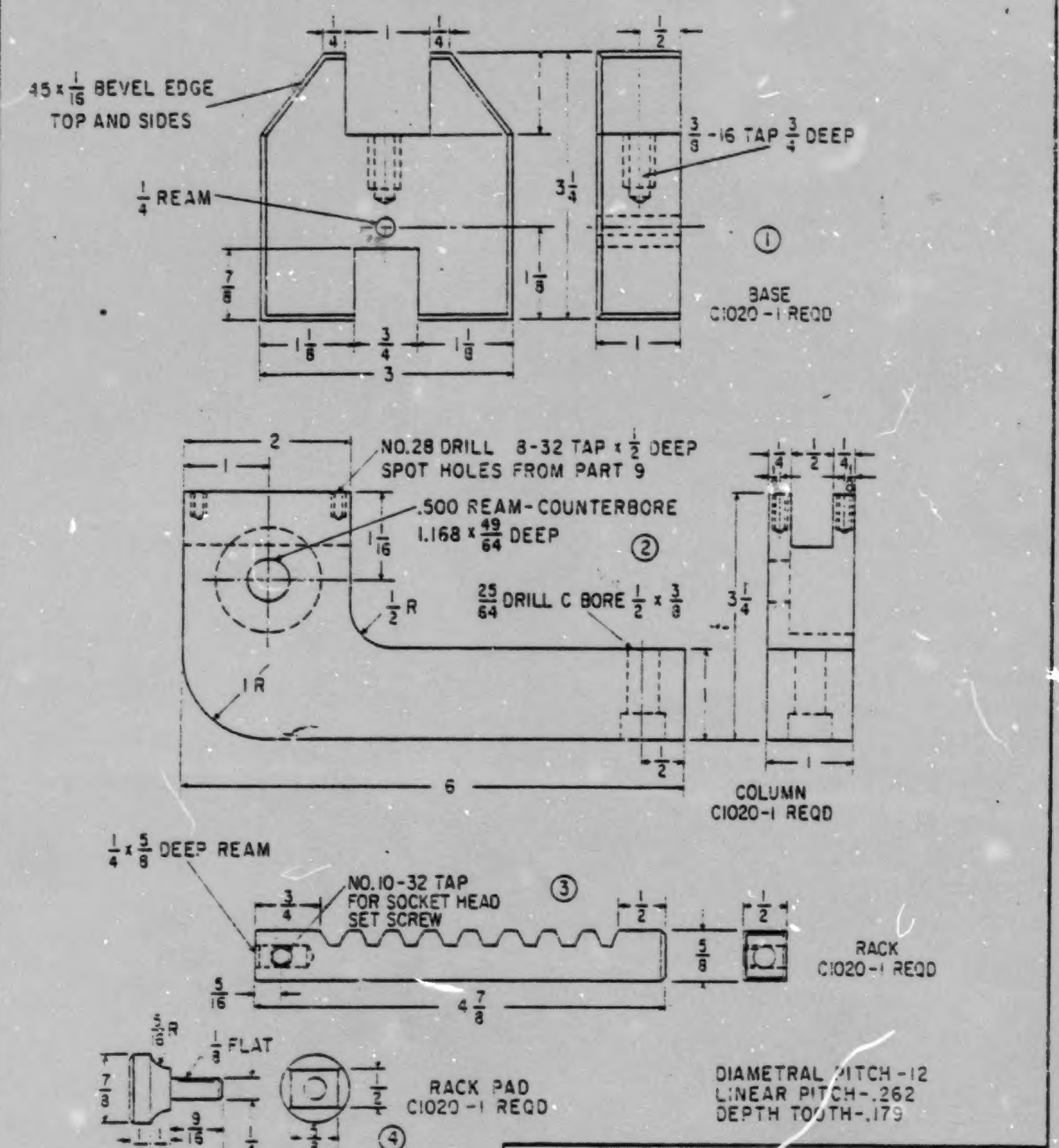
Part 1 of Drawing


5
$\frac{1}{2}$
.250 REAM
$\frac{9}{16}$
2
$\frac{7}{16}$
$\frac{3}{8}$
$\frac{1}{4}$
TABLE
C1020-1 REQD
6
$1\frac{9}{16}$
$\frac{3}{8}$
$\frac{3}{4}$ REAM
1.167
$\frac{3}{8}$ DRILL AT ASSEMBLY
SLEEVE
C1020-1 REQD
$\frac{1}{4}$ DRILL
82° x $\frac{9}{32}$ CSK
RIVET AFTER ASSEMBLY
$\frac{15}{32}$
$\frac{9}{16}$
BALL END
CRS-2 REQD
6
RIVET-FILE SMOOTH
7
HANDLE
C1020-1 REQD
NO.6 DRILL
$\frac{1}{4}$-20 TAP
$\frac{1}{2}$ DEEP
8
$\frac{3}{8}$ DRILL AT ASSEMBLY WITH SLEEVE
.500
.750
$1\frac{9}{16}$
$2\frac{5}{16}$
DIAMETRAL PITCH-12
NO. TEETH-12
OUTSIDE DIA 1.166
GEAR SHAFT
C1020-1 REQD
9
2
$\frac{1}{8}$
$\frac{1}{4}$
NO.18 DRILL
4 HOLES
COVER PLATE
C1020-1 REQD
10
$\frac{3}{4}$
$\frac{1}{16}$ SLOT x $\frac{3}{32}$ DEEP
$\frac{1}{4}$-20 THD
$\frac{1}{16}$
$\frac{3}{16}$
GEAR SHAFT SCREW
C1020-1 REQD
PRESS FIT IN PART 5
FREE FIT IN PART 1
.252
1
11
TABLE PIN
C1020-1 REQD

DO NOT SCALE DWG. – WORK TO FIGURES.
TOLERANCES: – UNLESS OTHERWISE SPECIFIED
DEC DIMS. ±.005 FRAC DIMS. $\pm\frac{1}{64}$ ANGULAR DIMS. ±1°

MATERIAL	HEAT-TREATMENT	FINISH	NAME
AS INDICATED	NONE	BAD	ARBOR PRESS

BEST COPY AVAILABLE


1/4
1
1/4
45 x 1/16 BEVEL EDGE
TOP AND SIDES
1/4 REAM
7/8
1 1/8
3/4
1 1/8
3
3 1/4
1 1/8
1/2
3/8 -16 TAP 3/4 DEEP
1
①
BASE
C1020 - I REQD
2
1
NO.28 DRILL 8-32 TAP x 1/2 DEEP
SPOT HOLES FROM PART 9
.500 REAM-COUNTERBORE
1.168 x 49/64 DEEP
1 1/16
②
1/2 R
25/64 DRILL C BORE 1/2 x 3/8
1 R
1/2
6
1/4
1/2
1/4
3 1/4
1
COLUMN
C1020-I REQD
1/4 x 5/8 DEEP REAM
NO.10-32 TAP
FOR SOCKET HEAD
SET SCREW
③
3/4
1/2
1/2
5/8
5/16
4 7/8
RACK
C1020-I REQD
5/16 R
1/8 FLAT
7/8
9/16
1/4
1/4
1/4
1/16
1/2
5/8
④
RACK PAD
C1020 -I REQD
DIAMETRAL PITCH -12
LINEAR PITCH-.262
DEPTH TOOTH-.179

DO NOT SCALE DWG. — WORK TO FIGURES.
TOLERANCES: — UNLESS OTHERWISE SPECIFIED
DEC DIMS. ±.005 FRAC DIMS. ±1/64 ANGULAR DIMS. ±1°

MATERIAL	HEAT-TREATMENT	FINISH	NAME
AS INDICATED	NONE	FAO	ARBOR PRESS

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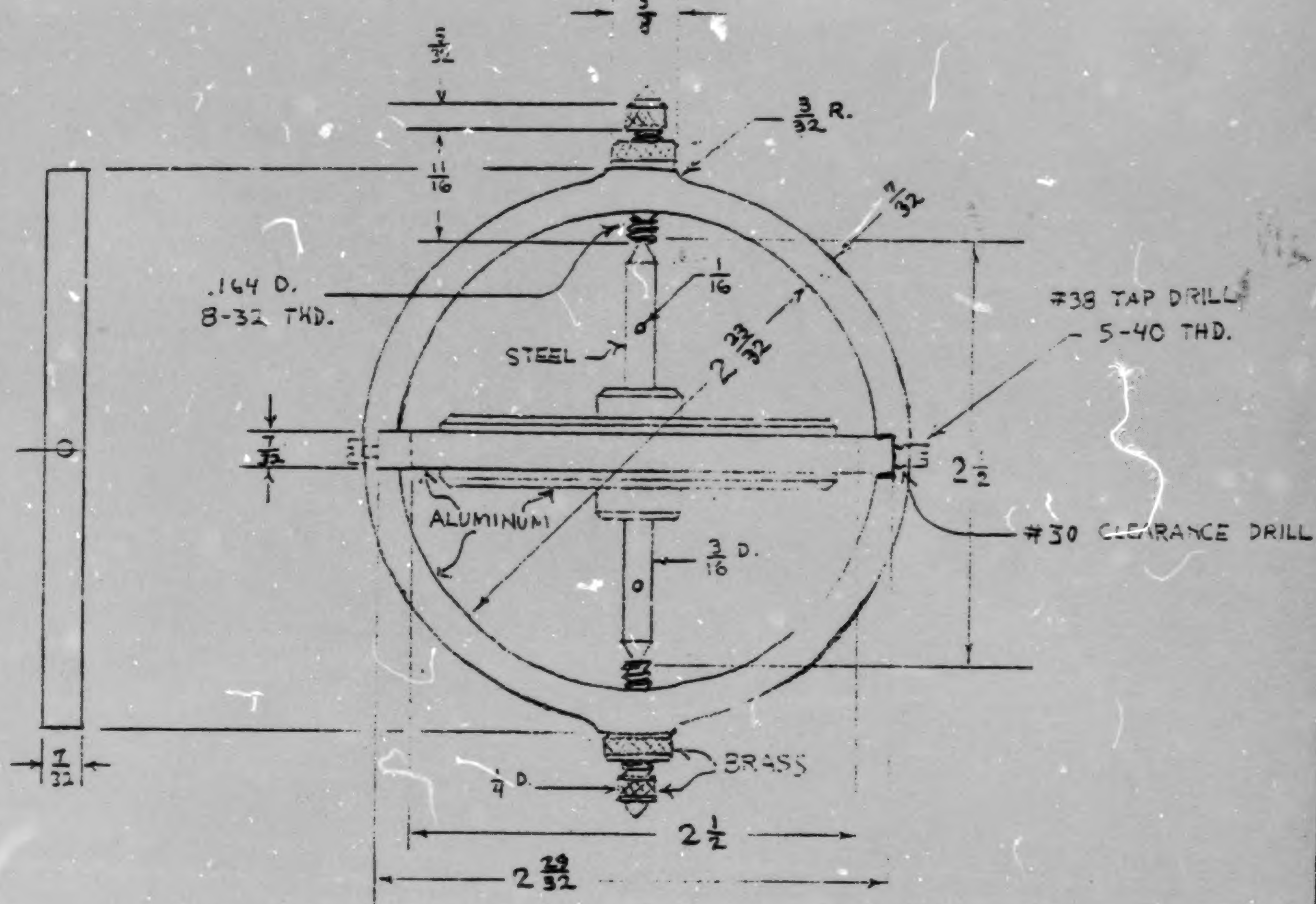
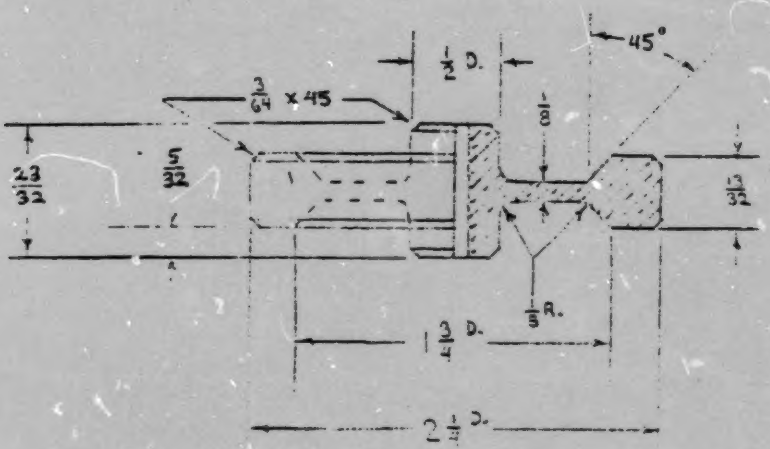

3/8
5/32
3/32 R.
11/16
7/32
.164 D.
8-32 THD.
1/16
STEEL
2 23/32
#38 TAP DRILL
- 5-40 THD.
7/32
2 1/2
ALUMINUM
#30 CLEARANCE DRILL
3/16 D.
BRASS
1/4 D.
7/32
2 1/2
2 29/32


1/2 D.
45°
3/64 x 45
1/8
23/32
5/32
13/32
1/8 R.
1 3/4 D.
2 1/4 D.

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GYROSCOPE
460-F 498

UNIT 19.0

MACHINE SHOP PROJECTS/LIVE WORK

An integral part of the secondary machine shop program is the use of machine shop projects designed to promote skill development and to simulate typical machining operations in industry. Occasionally, "live" projects for students, the School District, or the public may be used for training.

Typically, machine shop projects or "live" work will be used to accomplish a group of objectives rather than being used in an objective-by-objective method. Machining projects may utilize a combination of tasks from several different units such as layout, measuring, benchwork, lathe operation, etc.

Learning projects may be designed by the instructor for skill development or for the demonstration of competencies in performance processes or product production.

Prior to undertaking shop training or "live" projects, a detailed plan outlining objectives, actions necessary to obtain objectives, standards of performance and production, and the criteria for evaluation should be developed, understood by the student, and followed. (See accompanying form.)

See the description of First Year Learning Projects following Unit 9 and the description of the Second Year Learning Projects following this page.

Addendum to Task

SHOP PROJECTS: ____________________

RELATED CURRICULUM TOPIC: ____________________

TASK NOS: ________, ________, ________, ________, ________

PERFORMANCE OBJECTIVE:

(What is student given? What behavior is expected of student? What standard of performance is expected?)

DESCRIBE MAJOR STEPS OF TASK (JOB):	STEPS COMPLETED WHEN BELOW STANDARDS DEMONSTRATED
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

STANDARDS (CRITERIA) OF PERFORMANCE THAT INDICATES THAT STUDENTS HAS COMPLETED TASK:

PLANNED INSTRUCTIONAL TIME: ________ Hours

(Estimated travel to/from: ________ Hours On Job: ________ Hours)

DATE TASK STARTED: ________________ DATE TASK FINISHED: ________________

RELATED KNOWLEDGE TRAINING	RELATED SKILL TRAINING

NOTES/COMMENTS:

INSTRUCTOR: ATTACH PLANS, INSTRUCTIONS, TESTS, ETC.

RATIONAL FOR MACHINE SHOP PROJECTS
AND LIVE MACHINE SHOP JOBS FOR PUBLIC

Machine shop projects or "live" machine shop jobs provide an opportunity where the secondary student can apply theoretical training and can practice and develop skills in simulated or actual job situations.

Shop projects (or "live" jobs) should be coordinated as closely as possible with theoretical training so that the student logically moves from the study of the fundamentals to practical exercises and finally to live projects or competency testing in a simulated or actual job situation.

Emphasis in machine shop projects will be on operations that are related directly to the development of knowledges and skills that are being learned during the phase of instruction. With the instructor's approval, students often can bring in or accept practical jobs where related instruction has been given and competencies have been mastered. Occasionally, the machine shop program may need to take advantage of "machining opportunities" that may not be repeated at a later date and, under supervision of the instructor, basic instruction and "live" work may be conducted together in a practical job situation.

Generally, the production of the secondary level, machine shop student in the training lab (in practical work) will be low and slow compared to industry because the primary aim is on teaching. Emphasis in the machine shop program is placed on developing the correct skills for machining operations: A job not done "right" may have to be done over by the student.

Machine shop training projects or "live" work provides a unique opportunity for students to encounter, in a controlled setting, day-to-day machining operations that cannot be simulated. "Hands on" work in the machine shop provides learning experiences that otherwise only can be acquired through trial-and-error on the job.

Worthwhile projects and "live" machining operations, however, require more instructor planning. Careful scheduling is necessary to ensure that students are competent to accomplish the job within the given time and resources. In addition, "live" machining operations must be scheduled in the proper instructional sequence so that students can complete assigned projects so that competency development will proceed properly.

Practical learning opportunities involving "live" shop projects may be designed for special needs students, for the career interests of student, or to meet the needs of potential employers at a particular time. A secondary student already employed in a machining or related field may be able to develop specialized competencies through "additional experiences" provided by shop projects or "live" jobs.

Machine shop projects and "live" jobs provide the instructor with an optimum situation in which to test student knowledges and skills in realistic, "hands-on" examinations. In some situations, the "live" shop job may be utilized by the instructor as a method of conducting a final examination of a unit or units of instruction.

A side benefit that often accompanies shop projects or "live" jobs is when students tend to develop good work habits and attitudes in addition to increasing their technical knowledges and skills in machine operations.

SUGGESTIONS FOR MACHINE SHOP PROJECTS

1. Machining projects should begin with a clear, concise written objective or/and set of specifications.

2. "Live" shop jobs for outside of school use that expend materials should not begin until there is a specific description of the machining operation desired and until a deposit to cover costs of materials used has been obtained. The educational program/institution should not be expected to use the instructional budget to pay machining expenses for outside of program projects.

3. Machining projects and "live" jobs undertaken should be compatible with curriculum objectives. Students should not undertake work until they have been introduced to the appropriate theory, techniques, and procedures required for the job.

4. Each machining project should have appropriate checkpoints established and work should not progress beyond checkpoints until the job has been approved by the instructor.

5. Stock or parts provided by outside individuals should be appropriately protected.

6. Students should be able to verbally describe the objectives and purposes of the specific machining operation they are to perform.

7. A record or log should be kept of all materials or parts used in a live machining operation (generally omitted in training projects).

8. Students should record their time involved in machining projects and should indicate their name on the product or job record.

9. Students should not begin a machine operation without authorization from the instructor.

10. Work should not begin or continue if a safe situation does not exist.

11. Machining equipment should not be used unless the student has been checked out in the operation of the equipment, has the instructor's permission to operate the machine, and has need to use the machine. (INSTRUCTOR: INSERT COPY OF SHOP RULES AND PROCEDURES IN THIS GUIDE!)

12. Products of machine shop projects should be checked by the student and approved by the instructor.

13. Prior to releasing a product machined for the public, the instructor should verify the accuracy of the machining operation. Consideration should be given to obtaining a limited release of responsibility from the customer, if applicable.

TOOLROOM WORKER

(OPTIONAL)

Practical activities in the secondary machine shop program may include related training and experiences in the shop (lab) toolroom. Purposes that may be served by assigning the student to toolroom duty on a rotating basis include the following:

1. Assigning the student to periodic duty in the toolroom, on a rotating basis, provides a means of controlling expensive public property, essential to machine shop training.

2. Through toolroom duty, the student should learn responsibility, an important trait to successfully holding a job.

3. Toolroom duty can contribute directly to a reduction in damaged or missing tools and equipment. Misuse of tools and equipment can be identified and a student can be held accountable for the loss of training tools or equipment.

4. Through maintaining a log of all tools and equipment signed out and returned, there will be a current inventory of the tool or equipment rooms. Tools and equipment in use or borrowed can be identified as to location and user.

5. The activities of the toolroom duty student should include identifying tools, equipment, and parts by their proper names; proper storage of tools, equipment, and parts; and inspection, cleaning, and care of tools and equipment. This task should include a regular inventory of tool boxes, sets of tool items, etc., to identify missing or unserviceable components.

6. In addition, the toolroom duty student may be assigned the task of assisting the instructor in observing the lab (shop) area for possible safety infractions and fire hazards. In this task, the student can help the instructor ensure that a safe training environment is maintained.

   As a safety observer, the toolroom duty student should take action to prevent obstructed aisles and cluttered storage areas that might cause injury to others.

   The toolroom duty student should review posted first aid directions and be prepared to alert the instructor concerning accidents and to assist fellow students who receive minor injuries.

   The toolroom duty student should aid fellow students in following prescribed safety practices of the shop. For example, the student might remind others concerning the use of safety goggles, etc.

The toolroom duty student should observe the shop for potential fire hazards. The toolroom duty student should assist in recovering oily rags and waste material in proper containers and seeing that flammable solvents, oil, and chemicals are stored in fireproof areas.

The toolroom duty student should observe the shop for potential safety hazards such as exposed electrical wires, machines with safety guards not in place, etc., and alert fellow students to potential hazards.

The toolroom duty student should be prepared to notify the instructor of questionable safety situations, locate and use fire extinguishers, and assist students with first aid.

7. The knowledge and skills of the student assigned to toolroom duty might be expended through individualized study assignments or worksheets selected to prepare the student for career opportunities in counter or warehouse work in related fields (e.g., identification of fasteners, tools, machine parts, etc.).

UNIT 20.0

OXYACETYLENE (OAW) CUTTING/WELDING AND BRAZING

OPTIONAL
ADDENDUM MODULE

MACHINE SHOP WELDING

This optional addendum module concerning machine shop welding includes Unit 20, Oxyacetylene (OAW) Cutting, Welding, and Brazing, and Unit 21, Shielded Metal ARC Welding (SMAW).

The purpose of this module is to provide the secondary level machine shop student with the basic skills and knowledge in gas and electric welding operations that may be used in the machining trade.

Currently, only one of the three secondary level machine shop programs is equipped with a variety of welding trainers and is providing welding training. The other machine shop programs may have a small ARC welder and may provide an orientation to ARC welding.

The tasks described in this module were adopted from the Articulated, Performance-based Instruction Objectives Guide for Welding developed by The School District of Greenville County in 1983. For expanded training, other tasks may be added to those described in this module. The instructional goal of this module is to ensure that welding training, regardless of the vocational program in which it is offered, is designed properly, articulated, and safe.

NOTE: Post-secondary welding typically is taught by the Welding Department, GTC (post-secondary participant in articulation).

OXYACETYLENE WELDING, CUTTING, AND BRAZING

PREREQUISITES: None

OBJECTIVES: The objective of oxyacetylene welding, cutting, and brazing (OAW) is to develop entry level gas welding skills.

Oxyacetylene, welding, cutting, and brazing training develops the skills necessary to produce high quality single and multi-pass welds on mild steel in the flat, horizontal, vertical, and overhead positions. The machine shop student is trained to produce high quality flame cuts through the use of manual gas flame. The machinist will develop skills in producing high quality brazed joints.

Upon completing secondary training, the student should be skilled to set up OAW equipment and perform the requirements of OAW welding, cutting, and brazing in the machine shop.

Unit No. 20 Title: OXYACETYLENE CUTTING/WELDING

MODULE STANDARDS

(Standards that are in effect for the entire module and that are not optional. Standards applicable only to a particular set of tasks or functions will be described on the Performance Standards page.)

1. Select tip.
    a. Proper size for work to be done (thickness of metal).
2. Inspect tip for signs of damage or flaws that could create a hazard or impair performance.

a.	Seat area:	Smooth and clean to ensure good metal seal with torch head.
b.	Cutting oxygen orifice:	Free of slag or spatter or other obstruction that may deform oxygen stream and render a poor quality cut.
c.	Pre-heat flame orifices:	Free of obstruction. (Clogged or obstructed orifices will extend required pre-heat time and result in poor performance and cutting efficiency.)
d.	O-Rings:	Check for deterioration.

3. Install tip.
4. Set gas pressures for desired working pressure.

MACHINE SHOP
GAS WELDING
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 20.0	OXYACETYLENE (OAW) CUTTING/WELDING AND BRAZING	
20.01	Oxyacetylene Cutting/Welding Terminology	
20.02	Oxyacetylene Cutting/Welding Safety	
20.03	Perform Soap and Water Test (Safety)	
20.04	Identify Oxygen and Acetylene Gases and Cylinder Handling	
20.05	Set Up Oxyacetylene Cutting/Welding Station	
20.06	Clean Oxyacetylene Cutting/Welding Tips	
20.07	Light the Torch	
20.08	Adjusting Flame	
20.09	Oxyacetylene Cutting	
20.10	Preparing the Joint	
20.11	Carrying the Puddle (Fuse)	
20.12	Run a Bead with Filler Rod	
20.13	Weld Open Butt Joint, All Positions	
20.14	Fillet Weld, Lap Joint, Flat and Overhead Positions	
20.15	Braze Metal	

Times not estimated. (Optional training)

TASK LISTINGS
MACHINE SHOP

UNIT/TASK	DESCRIPTION
Unit 20.0	OXYACETYLENE (OAW) CUTTING/WELDING AND BRAZING
20.01	(Oxyacetylene Cutting/Welding Terminology) Given proper instructions, identify standard oxyacetylene cutting/welding terms, typically used in daily operations, on a written test with 80 percent accuracy. Use standard oxyacetylene cutting/welding terminology upon completion of the training module to the standards of the instructor.
20.02	(Oxyacetylene Cutting/Welding Safety) Given proper instructions concerning oxyacetylene cutting/welding safety; demonstrate proper use of protective clothing and equipment to protect against hazards in gas cutting/welding with 100 percent accuracy.
20.03	(Perform Soap and Water Test [Safety]) Given oxyacetylene cutting/welding equipment to be tested for leaks, neutral soap and water, and proper instruction; perform a soap and water leak test. Mark (with tape, etc.) all discovered leaks for repair. Hoses and torch will not leak after repair and test.
20.04	(Identify Oxygen and Acetylene Gases and Cylinder Handling) Given proper instructions and demonstration, identify with 100 percent accuracy characteristics of oxygen and acetylene gases and demonstrate proper handling of cylinders to the standards of the instructor.
20.05	(Set Up Oxyacetylene Cutting/Welding Station) Given oxyacetylene torch, regulators, hoses, check valves, cylinder wrench, oxygen, and fuel cylinders and portable cart; set up a portable or stationary oxyacetylene cutting/welding station. The oxy-fuel equipment will not leak and will operate safety as the manufacturer intended.
20.06	(Clean Oxyacetylene Cutting/Welding Tips) Given oxyacetylene cutting/welding equipment, tip cleaners, and instructions; clean both cutting/welding tips.
20.07	(Lighting the Torch) Given oxyacetylene cutting/welding equipment, striker, sample metal to be used in job; light torch (for cutting).
20.08	(Adjusting Flame) Given oxyacetylene cutting/welding equipment including striker, adjust flame for job.
20.09	(Oxyacetylene Cutting) Given oxyacetylene cutting equipment, set up the equipment for a cutting job, and cut given metal according to instructor's assignment.

20.10 (Preparing the Joint) Given metal to clean and prepare for welding, select the best joint and prepare the joint for welding.

20.11 (Carrying the Puddle [Fuse]) Given oxyacetylene welding equipment and metal to weld without filler rod, establish a molten puddle and run straight even beads (without filler) in the flat or other positions assigned by the instructor.

20.12 (Run a Bead with Filler Rod) Given oxyacetylene welding equipment, metal, and filler rod, demonstrate the proper procedure for carrying the puddle with filler metal in the flat position or other positions that may be required by the instructor, to the instructor's standards.

20.13 (Weld Open Butt Joint, All Positions) Given oxyacetylene welding station, filler rod, metal panels, personal safety equipment, and necessary tools and materials; groove weld a butt joint in all positions required by the instructor. The bead should be formed properly, straight, and uniform in ripple and width, with even height.

20.14 (Fillet Weld, Lap Joint, All Positions) Given oxy-fuel work station, metal, rods; construct a lap weld in all positions, required by the instructor. The weld will be straight, have consistency of width and height, proper build up, and no slag.

20.15 (Braze Metal) Given an oxyacetylene welding station, sheet metal, brazing rod, flux, personal safety equipment, and the necessary tools and materials; braze metal. Bead must be straight and uniform in height and width, have a uniform ripple formation and have no undercut, porosity, craters, or oxidation.

UNIT 20.0 OXYACETYLENE

TASK 20.01 OXYACETYLENE CUTTING/WELDING TERMINOLOGY

PERFORMANCE OBJECTIVE:

Given proper instructions, identify standard oxyacetylene cutting/welding terms, typically used in daily operations, on a written test with 80 percent accuracy. Use standard oxyacetylene cutting/welding terminology upon completion of the training module to the standards of the instructor.

PERFORMANCE STANDARDS:

20.0101 Eighty percent accuracy in identifying standard terminology typically used in oxyacetylene cutting/welding jobs.

20.0102 Upon completion of Module 4.0, use terminology to instructor's standards.

Terms and definitions adapted from: Welding, Cutting & Heating Guide, Denton, TX: Victor Equipment Co., pp. 54-57, 1977.

DEFINITIONS

ACETYLENE - Gas composed of two parts of carbon and two parts of hydrogen. When burned in an atmosphere of oxygen, it produces one of the highest flame temperatures obtainable.

ACETYLENE CYLINDER - Specially built container manufactured according to D.O.T. standards. Used to store and ship acetylene. (Occasionally called "tank" or "bottle.")

ACETYLENE REGULATOR - An automatic valve used to reduce acetylene cylinder pressures to torch pressures and to keep the pressures constant.

BEAD - Denotes the appearance of the finished weld; describes the neatness of the ripples formed by the metal while it was in an semiliquid state.

BEVEL - Angling the metal edge where welding is to take place.

BOND - Junction of the weld metal and the base metal.

BUILDUP - Amount a weld face is extended above the surface of the metals being joined.

UNIT 20.0 OXYACETYLENE

TASK 20.01 OXYACETYLENE CUTTING/WELDING TERMINOLOGY

DEFINITIONS CON'T.

BUTT JOINT - An assembly in which the two pieces joined are in the same plane, with the edge of one piece touching the edge of the other.

CARBURIZING - A carburizing flame is an oxygen-fuel gas flame with a slight excess of the fuel gas.

CONE - Inner visible flame shape of a neutral or near neutral flame.

CONTINUOUS WELD - Making the complete weld in one operation.

CORNER JOINT - Junction formed by edges of two pieces of metal touching each other at angle 90 degrees.

CRACKING - Action of opening a valve slightly and then closing the valve immediately.

CUTTING FLAME - Cutting by a rapid oxidation process at a high temperature. It is produced by a gas flame accompanied by a jet action which blows the oxides away from the cut.

CYLINDER - A container used to hold gases used in welding. See (Oxygen, Acetylene.)

EDGE JOINT - Joint formed when two pieces of metal are lapped with at least one edge of each at an edge of the other.

FILLER ROD - Metal wire that is melted and added to the welding puddle to produce the necessary increase in bead thickness. (See Welding Rod.)

FILLET - Weld metal in the internal vertex, or corner, of the angle formed by two pieces of metal, given the joint additional strength to withstand unusual stresses.

FILLET WELD - Metal fused into a corner formed by two pieces of metal whose welded surfaces are approximately 90 degrees to each other.

FLAME CUTTING - Cutting performed by an oxygen-fuel gas torch which has an oxygen jet.

FLAT POSITION - A horizontal weld on the upper side of a horizontal surface.

FUSION - Intimate mixing of molten metals.

DEFINITIONS CON'T.

HORIZONTAL POSITION - A weld performed on a horizontal seam at least partially on a vertical surface.

HOSE - Flexible medium used to carry gases from regulator to the torch. It is made of fabric and rubber.

JOINT - Where two pieces meet when a structure is made of smaller pieces.

LAP JOINT - A joint in which the edges of the two metals to be joined overlap one another.

LENS - A specially treated glass through which a welder may look at an intense flame without being injured by the harmful rays, or glare, radiating from this flame.

NEUTRAL FLAME - Flame which results from combustion of perfect proportions of oxygen and the welding gas. Used for most welding jobs.

ORIFICE - Opening through which gases flow. It is usually the final opening; or any opening controlled by a valve.

OUTSIDE CORNER WELD - Fusing two pieces of metal together, with the fusion taking place on the underpart of the seam.

OXIDIZING - Combining oxygen with any other substance. For example, a metal is oxidized when the metal is burned, i.e., oxygen is combined with all the metal or parts of it.

OXIDIZING FLAME - Flame produced by an excess of oxygen in the torch mixture, leaving some free oxygen which tends to burn the molten metal.

OXYGEN - A gas formed of the element oxygen. When it very actively supports combustion it is called burning; when it slowly combines with a substance it is called oxidation.

OXYGEN-ACETYLENE CUTTING - Cuting metal using the oxygen jet which is added to an oxygen-acetylene preheating flame.

OXYGEN-ACETYLENE WELDING - A method of welding which uses a fuel combination of two gases - oxygen and acetylene.

OXYGEN CYLINDER - A specially built container manufactured according to D.O.T. standards and used to store and ship oxygen.

DEFINITIONS CON'T.

OXYGEN REGULATOR - An automatic valve used to reduce cylinder pressures to torch pressures and to keep the pressures constant. They are never to be used as acetylene regulators.

PASS - Weld metal created by one progression along the weld.

PENETRATION - Depth of fusion into the base metal as measured from the surface of the base metal.

PREHEATING - Temperature to which a metal is heated before an operation is performed on the metal (welding, cutting, forming, etc.).

PUDDLE - Portion of a weld that is molten at the place the heat is supplied.

ROOT of WELD - That part of a weld farthest from the application of weld heat and/or filler metal side.

SLAG INCLUSIONS - Non-fused, non metallic substances in the weld metal.

TACK WELD - Small weld used to temporarily hold together components of an assembly.

T-Joint - Joint formed by placing one metal against another at an angle of 90 degrees. The edge of one metal contacts the surface of the other metal.

TIP - Part of the torch at the end where the gas burns, producing the high-temperature flame. In resistance welding, the electrode ends are sometimes called tips.

TOE of WELD - Junction of the face of the weld and the base metal.

TORCH - The mechanism which the operator holds during gas welding and cutting, at the end of which the gases are burned to perform the various gas welding and cutting operations.

WELDING - Art of fastening metals together by means of interfusing the metals.

WELDMENT - Assembly of component parts joined together by welding.

UNIT 20.0 OXYACETYLENE

TASK 20.02 OXYACETYLENE CUTTING/WELDING SAFETY

PERFORMANCE OBJECTIVE:

Given proper instructions concerning oxyacetylene cutting/welding safety; demonstrate proper use of protective clothing and equipment to protect against hazards in gas cutting/welding with 100 percent accuracy.

PERFORMANCE ACTIONS:

20.0201 Identify different types and uses of body protection clothing and devices used in gas cutting/welding with 100 percent accuracy:

a. Goggles: One-piece and two-piece to filter light rays and protect eyes from hot metal and sparks.
b. Welding gloves.
c. Protective clothing:
  (1) Welding aprons, are recommended.
  (2) Recommendation not to wear trousers with cuffs.
  (3) Leather shoes or boots. (Recommendation: Do not wear canvas/cloth shoes.)

20.0202 Check oxyacetylene cutting/welding equipment for safe operation:

a. Test all hose and regulator connections with soap solution *(orientation task).
b. Never use oil or grease near oxygen and other fittings.
c. Identify oxygen and fuel cylinders without error.
d. Verify that cylinders are fastened in position correctly.
e. Inspect hoses, regulators for wear.
f. Check storage of empty and full cylinders for proper separation, position of cylinders, etc.

*See task on "Perform Soap and Water Test"

20.0203 Check oxyacetylene cutting/welding work area for proper ventilation. Should meet OSHA Standards.

PERFORMANCE ACTIONS (Con't.):

20.0204 Demonstrate Safe Practices:

a. Use caution in picking up pieces of hot metal. Use pliers or tongs. Mark "hot" metal left to cool.
b. Keep combustibles from heat.
c. Protect others from heat and hot slag.
d. Don't weld a completely closed container (Danger of expansion explosion).

PERFORMANCE STANDARDS:

- Identify proper safety in oxyacetylene cutting/welding on a written knowledge test to acceptable standards of instructor.
- Demonstrate use of protective equipment used in cutting/welding.
- Demonstrate safe practices in welding.
- Practice proper ventilation techniques in cutting/welding.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Identification of welding equipment.
- Orientation to dangers of oxyacetylene cutting/welding fumes of flash to welders.

NOTE: See "Safety Precautions for Oxygen and Acetylene," South Carolina Curriculum Guide for Welding, Columbia, SC: SC State Department of Education (Office of Vocational Education), 1972.

UNIT 20.0 OXYACETYLENE

TASK 20.03 PERFORM SOAP AND WATER TEST (SAFETY)

PERFORMANCE OBJECTIVE:

Given oxyacetylene cutting/welding equipment to be tested for leaks, neutral soap and water, and proper instruction; perform a soap and water leak test. Mark (with tape, etc.) all discovered leaks for repair. Hoses and torch will not leak after repair and test.

PERFORMANCE ACTIONS:

20.0301	Close torch valves.
20.0302	Apply normal pressure.
20.0303	Mix neutral soap and water.
20.0304	Brush soapy water over hoses and valves.
20.0305	Check for bubbles.
20.0306	Mark discovered leaks with tape.
20.0307	Relieve hose pressure.
20.0308	Repair hoses and torch as required.
20.0309	Recheck for leaks.

PERFORMANCE STANDARDS:

- Perform soap and water leak test on oxyacetylene cutting/welding equipment to instructor's standards.

SUGGESTED INSTRUCTION TIME: Orientation Task

RELATED TECHNICAL INFORMATION:

- Oxy-fuel cutting/welding equipment.
- Proper safety precautions.

UNIT	20.0	OXYACETYLENE
TASK	20.04	IDENTIFYING OXYGEN AND ACETYLENE GASES AND CYLINDER HANDLING

PERFORMANCE OBJECTIVE:

Given proper instructions and demonstration, identify with 100 percent accuracy characteristics of oxygen and acetylene gases and demonstrate proper handling of cylinders to the standards of the instructor.

PERFORMANCE ACTIONS:

20.0401
- a. Identify with 100 percent accuracy characteristics of oxygen and acetylene gases.
- b. Describe potential dangers in handling both gases and typical pressures under which gases should be used.

20.0402 Identify difference between oxygen and acetylene cylinder with 100 percent accuracy.

20.0403 Demonstrate proper handling of gas cylinders:

- a. Fasten cylinders securely in upright position.
- b. Use proper method (or tool) to open/close cylinder valves.
- c. Demonstrate proper storage of cylinders.
- d. Demonstrate proper handling of cylinders in training.

PERFORMANCE STANDARDS:

- Identify major characteristics of oxygen and acetylene gases that apply to welding on a written knowledge test with 100 percent accuracy.
- Demonstrate proper handling of gas cylinders to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: Optional training

UNIT 20.0 OXYACETYLENE

TASK 20.05 SET UP OXYACETYLENE CUTTING/WELDING STATION

PERFORMANCE OBJECTIVE:

Given oxyacetylene torch, regulators, hoses, check valves, cylinder wrench, oxygen, and fuel cylinders and portable cart; set up a portable or stationary oxyacetylene cutting/welding station. The oxy-fuel equipment will not leak and will operate safely as the manufacturer intended.

PERFORMANCE ACTIONS:

20.0501 Chain cylinders to cart.

20.0502 Remove cylinder cap.

20.0503 Crack cylinder valves to clean out foreign particles and inspect threads.

20.0504 Attach regulators.

20.0505 Install check valves.

20.0506 Attach hoses.

20.0507 Attach hoses to torch. (Set proper pressure for tips being used.)

20.0508 Check for leaks.

PERFORMANCE STANDARDS:

- Oxy-fuel equipment will not leak and will operate safely as the manufacturer intended.
- Minimum on knowledge test concerning cylinder handling, regulators, and set up of oxy-fuel welding equipment.
- Set up oxyacetylene cutting/welding station to instructor's standards.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Safety:
  a. Cylinder storage and handling
  b. Purging equipment
  c. Gas: (1) Pressures, (2) Ventilation
  d. Inspection procedures
- Manufacturer's specifications and instructions.

UNIT 20.0 OXYACETYLENE

TASK 20.06 CLEAN OXYACETYLENE CUTTING/WELDING TIPS

PERFORMANCE OBJECTIVE:

Given oxyacetylene cutting/welding equipment, tip cleaners, and instructions; clean both cutting/welding tips.

(NOTE: This objective will become standard practice when using oxyacetylene welding and cutting equipment.)

PERFORMANCE ACTIONS:

20.0601 Examine tip to determine orifice (opening) size, and condition of orifice end of tip.

20.0602 Select proper (correct size) tip cleaner(s).

20.0603 (May be optional or orientation only). Smooth flame end of tip if it is scratched or rough (file orifice end) or use tip reamer.

20.0604 Clean tip:

a. Start with tip cleaner two sizes smaller than tip orifice.
b. Use straight push-pull action to eliminate egg-shaped opening.
c. Gradually increase tip cleaner size to original orifice size.
d. Where possible, insert long tip cleaners through back of tip.

PERFORMANCE STANDARDS:

- Clean tips to instructor's standards or manufacturer's recommendations, avoiding damage to tip, and reporting and damaged tips to instructor.

SUGGESTED INSTRUCTION TIME: Orientation more than skill development

RELATED TECHNICAL INFORMATION:

- Determine that tips are being used with torches from the same manufacturer.
- Identify various tips.
- Identify typical tip sizes (No standard numbering system).

UNIT 20.0 OXYACETYLENE

TASK 20.07 LIGHTING THE TORCH

PERFORMANCE OBJECTIVE:

Given oxyacetylene cutting/welding equipment, striker, sample metal to be used in job; light torch (for cutting).

(NOTE: Tasks of (a) lighting the torch and (b) adjusting the flame typically will be accomplished as a continuing action.)

PERFORMANCE ACTIONS:

20.0701 Select proper tip size for job. (Determine by thickness of metal.)

20.0702 Set regulator pressure for job.

20.0703 a. Open oxygen valve on torch handle.
b. Adjust oxygen regulator to desired delivery range.

20.0704 a. Open fuel valve on torch handle (1/2 turn).
b. Adjust fuel regulator to required delivery tange.

20.0705 Point torch head (flame direction) away from persons, cylinders, or flammable materials before lighting.

20.0706 a. Open torch fuel valve approximately 1/2 turn.
b. Ignite gas. Hold torch in one hand and the spark lighter in the other hand.

PERFORMANCE STANDARDS:

- Select proper tip for welding job; adjust regulators according to text or teacher's instructions or manufacturer's standards; use proper safety equipment; and light torch.
- (Tash typically will be accomplished jointly with adjusting flame.)

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Able to set up oxy-fuel cutting/welding station.
- Selection of cutting/welding tips.
- Wear protective goggles to shield against bright light.

UNIT 20.0 OXYACETYLENE

TASK 20.08 ADJUSTING FLAME

PERFORMANCE OBJECTIVE:

Given oxyacetylene cutting/welding equipment including striker, adjust flame for job.

(NOTE: Tasks of (a) lighting torch and (b) adjusting flame typically will be accomplished as a continuous action.)

PERFORMANCE ACTIONS:

20.0801 Light torch. (Point flame away from persons, cylinders, or any flammable materials.)

20.0802 a. Keeping opening fuel valve until flame stops smoking and leaves end of tip by about 1/8 inch.
b. Then, slightly reduce fuel supply to bring flame back to tip.

20.0803 Open torch oxygen needle adjustment valve until a bright neutral flame (for cutting) is reached.

PERFORMANCE STANDARDS:

- Adjust torch to a neutral flame (for cutting) to meet manufacturer's specifications, or instructor's standards.
- (Task may be accomplished jointly with lighting the torch.)

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

Caution: If backfire or flashback is experiences, immediately turn off oxygen valve, then turn off fuel valve.

- Oxidizing flame.
- Carburizing flame.

UNIT 20.0 OXYACETYLENE

TASK 20.09 OXYACETYLENE CUTTING

PERFORMANCE OBJECTIVE:

Given oxyacetylene cutting equipment, set up the equipment for a cutting job, and cut given metal according to instructor's assignment.

PERFORMANCE ACTIONS:

20.0901 Make usual preparations for cutting.

20.0902
- a. Set oxygen regulator.
- b. Set acetylene regulator.
- c. Adjust as necessary.

20.0903
- a. Turn on acetylene valve.
- b. Light torch with sparklighter (striker). (NOTE: Avoid using butane lighters and matches!)

20.0904
- a. Turn on oxygen preheating valve.
- b. Adjust to neutral flame.

20.0905 Press oxygen high-pressure lever and observe preheating flame.

20.0906 Position metal.

20.0907
- a. Hold torch tip at right angle to metal with inner cones +/- 1/2 inch above metal.
- b. Heat edge of metal to bright red (at guideline).
- c. Press oxygen cutting level and move torch forward along guidelines to begin cut.

20.0908 Move torch fast enough to maintain smooth, even cut on metal. (If cutting actions stops, release oxygen cutting level and preheat at end of kerf and continue cut when metal becomes red.)

PERFORMANCE STANDARDS:

- Set up complete oxyacetylene cutting station following proper sequence and safety precautions.
- Light and properly adjust flame for cutting job.
- Cuts must meet the instructor's standards and industry standards. (NOTE: Proper cutting speed can be mastered only through experience.)

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Oxyacetylene safety: Equipment, operation, personal.
- Cut lines outlined by soapstone or chalk.

RECOMMENDED:

- Use only enough flame to cut metal.

UNIT 20.0 OXYACETYLENE

TASK 20.10 PREPARING THE JOINT

PERFORMANCE OBJECTIVE:

Given metal to clean and prepare for welding, select the best joint and prepare the joint for welding.

PERFORMANCE ACTIONS:

20.1001 Select type of joint: (Select simplest joint to produce strongest weld possible.)

20.1002
a. Lap.
b. Butt.
(NOTE: Instructor may require orientation to Edge, Corner, and T joints.)

20.1003 Prepare joint.

20.1004
a. Prepare metal for deep penetration, keeping metal edges true and straight.
b. Clean and dry metal prior to welding.

PERFORMANCE STANDARDS:

- The best (simplest) joint to produce the strongest weld possible must be chosen as judged by the welding instructor and the joint must be properly prepared for welding, to include free from any material that might weaken the weld.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Oxyacetylene cutting.
- Metal characteristics (thickness and appropriate welding joints).
- Consideration in alignment of long lengths of body panels for lap weld.

UNIT 20.0 OXYACETYLENE

TASK 20.11 CARRYING THE PUDDLE (FUSE)

PERFORMANCE OBJECTIVE:

Given oxyacetylene welding equipment and metal to weld without filler rod, establish a molten puddle and run straight even beads (without filler) in the flat or other positions assigned by the instructor.

PERFORMANCE ACTIONS:

20.1101 Put on safety equipment.

20.1102 Position metal as instructed and to the standards of the instructor.

20.1103 Set up oxyacetylene welding station and adjust regulators.

20.1104 Light torch and adjust for a neutral flame.

20.1105 Point flame in direction of weld at 35-45 degree angle with no side angle.

20.1106 Lower torch until inner flame is about 1/2 inch from metal.

20.1107 (Recommend) Begin weld at right hand edge of metal. (If right handed.)

20.1108 Move flame in small circle until pool of molten metal forms (about 1/4 inch in diameter).

20.1109 Move flame along line of intended weld to form overlapping circles (carry the puddle) in uniform bead. (Scribe a line or use a straight edge to help puddle a straight bead.)

(NOTE: Practice will be required to develop skill in puddling.)

PERFORMANCE STANDARDS:

- Run a bead without filler rod, according to the instructor's standards, keeping the bead straight and maintaining a uniform puddle.

SUGGESTED INSTRUCTION TIME: Optional training

UNIT 20.0 OXYACETYLENE

TASK 20.11 CARRYING THE PUDDLE (FUSE) (Con't.)

RELATED TECHNICAL INFORMATION:

- Safety procedures.
- Setting up oxy-fuel station.
- Flame adjustment.

UNIT 20.0 OXYACETYLENE

TASK 20.12 RUN A BEAD WITH FILLER ROD

PERFORMANCE OBJECTIVE:

Given oxyacetylene welding equipment, metal, and filler rod, demonstrate the proper procedure for carrying the puddle with filler metal in the flat position or other positions that may be required by the instructor, to the instructor's standards.

PERFORMANCE ACTIONS:

20.1201 Put on safety equipment. Take safety precautions.

20.1202 Position metal.

20.1203 Set up oxy-fuel welding station.

20.1204
a. Establish puddle with torch angle 30-45 degrees.
b. Place inner cone about 1/2 inch from metal puddle.

20.1205 Begin travel when a molten puddle is established.

20.1206 Add filler rod to puddle, withdraw as necessary.

20.1207 Move puddle forward with torch, allowing puddle to form in base metal.

20.1208 Maintain puddle size and shape so that bead is smooth and in a straight line.

(NOTE: Practice will be required to develop consistently satisfactory results in running a bead.)

PERFORMANCE STANDARDS:

- Using oxyacetylene welding, run a bead with filler rod, in a straight line, with uniform width and height, with a weld penetrating about 100 percent thickness of metal base, consistently satisfactory to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Filler rod.
- Tip selection.
- Puddling.

UNIT 20.0 OXYACETYLENE

TASK 20.13 WELD OPEN BUTT JOINT, ALL POSITIONS*

PERFORMANCE OBJECTIVE:

Given oxyacetylene welding station, filler rod, base metal, personal safety equipment, and necessary tools and materials; groove weld a butt joint in all positions required by the instructor. The bead should be formed properly, straight, and uniform in ripple and width, with even height.

PERFORMANCE ACTIONS:

20.1301 Prepare for oxy-fuel welding.

20.1302 Position metal in butt joint, flat position.

20.1303 Tack weld each end of the joint to hold position.

20.1304 Run a bead, using acceptable standards (of industry), to weld a butt joint (all positions).

20.1305 Inspect weld for:

a. Proper penetration (100 percent).
b. Build up of weld around 1/16 inch above base surface.
c. Bead straight and over center of joint.

PERFORMANCE STANDARDS:

- Weld a butt joint.
- The bead must be properly formed, straight, and uniform in ripple and width, with even height.
- There must be no undercut, porosity, craters, or oxidation, and the weld must be fused with the base metal.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Tip and rod selection.
- Preparing metal for weld.
- Testing of weld.
- Safety.

*ALL POSITIONS = Flat, Horizontal, Vertical, and Overhead (to lesser degree)

UNIT	20.0	OXYACETYLENE
TASK	20.14	FILLET WELD, LAP JOINT, ALL POSITIONS*

PERFORMANCE OBJECTIVE:

Given oxy-fuel work station, metal, rods; construct a lap weld in all positions, required by the instructor. The weld will be straight, have consistency of width and height, proper build up, and no slag.

PERFORMANCE ACTIONS:

20.1401 Make necessary preparations for welding.

20.1402 Position sheet metal for lap welding.

20.1403 Tack weld each of the plates.

20.1404 Start molten pool at end of joint, with or without filler rod and run bead to complete lap joint.

20.1405 Inspect weld for smoothness, even ripple, uniform and complete penetration.

(SPECIAL NOTE: Practice in oxyacetylene lap joint welding typically will be limited to conserve practice steel.)

PERFORMANCE STANDARDS:

- Weld lap joint of metal with oxyacetylene equipment.
- The weld must be consistent and uniform, show uniform fusion, good surface ripple, and have no slag.
- The finished weld must meet the instructor's standards.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Welding procedures to ensure proper heating of top and bottom metal.
- Safety.

*Secondary training may concentrate on flat position.

UNIT 20.0 OXYACETYLENE

TASK 20.15 BRAZE METAL

PERFORMANCE OBJECTIVE:

Given an oxyacetylene welding station, metal, brazing rod, flux, personal safety equipment, and the necessary tools and materials; braze metal. Bead must be straight and uniform in height and width, have a uniform ripple formation and have no undercut, porosity, craters, or oxidation.

PERFORMANCE ACTIONS:

20.1501 Set up oxyacetylene welding station for brazing.

20.1502 Prepare sheet metal for brazing: Clean appropriately.

20.1503 Position and tack weld metal.

20.1504 Braze weld butt joint using slightly oxidizing flame.

20.1505 a. Use flux coated filler rod. OR
(1) Heat end of filler rod.
(2) Dip rod in flux allowing flux to cling to heated metal if not flux coated rod.
b. Heat tack welded areas to dull red; apply filler metal.

20.1506 Inspect weld.

PERFORMANCE STANDARDS:

- Braze weld metal so that the finished weld is flat to slightly convex, gold in color and penetrates through the joint.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- When/when not to braze.
- Precaution against embrittlement.

CHECKLIST FOR WELD

	CHECK IF WELD PASSES INDUSTRY STANDARDS (omit if it does not)				
	Flat	Horizontal	Vertical	Overhead	*
1. Even bead.					
2. Even ripples in bead.					
3. Bead uniform in width.					
4. Proper height in bead (not excessive).					
5. No holes in weld.					
6. Weld not brittle.					
7. No excessive metal under joint.					
8. Proper penetration.					
9. No weld cracks.					
10. End crater filled.					
11. No cold overlaps along joint seam.					
12. Good fusion and penetration.					

*Optional task at secondary level.

UNIT 21.0

SHIELDED METAL ARC WELDING (SMAW)
(ARC)

SHIELDED METAL ARC WELDING (SMAW)

(ARC)

PREREQUISITE: None

OBJECTIVE: Shielded Metal Arc Welding (SMAW) is designed to develop basic ARC welding skills for entry-level machine shop work.

The student will learn the skills of striking the arc, maintain proper arc length, setting up SMAW equipment, and manipulating the electrode.

MACHINE SHOP
SHIELDED METAL ARC WELDING
SUGGESTED INSTRUCTION TIMES

MACHINE SHOP UNIT/TASK		SUGGESTED HOURS
Unit 21.0	SHIELDED METAL ARC WELDING	
21.01	Introduction (Principles) of Arc Welding	
21.02	Safety in Arc Welding	
21.03	Machines and Accessories	
21.04	Select Electrode	
21.05	Striking and Maintaining (Substaining) an Arc (Flat Position)	
21.06	Chip Slag Using Chipping Hammer	
21.07	Run Short Beads, Flat Position (Training Task)	
21.08	Run Continuous Beads, Flat Position (Training Task)	
21.09	Prepare Joint	
21.10	Construct Open Butt Weld, All Positions	
21.11	Construct Lap Joint Weld, 3/8 Inch Equal Legs, Three Passes	

Times not estimated. (Optional training)

UNIT/TASK	DESCRIPTION
Unit 21.0	SHIELDED METAL ARC WELDING
21.01	(Introduction [Principles] of Arc Welding) Given instruction and an orientation to various welding processes, identify shielded metal arc welding as a process, describe the electric arc.
21.02	(Safety in Arc Welding) Given instruction concerning arc welding safety, demonstrate safety precautions recommended by the instructor and text (industry standards) concerning the handling of hot metal, high current electricity, toxic fumes, large quantities of ultraviolet rays, droplets of molten metals, and proper setting of arc welding machines.
21.03	(Machines and Accessories) Given instruction concerning machines and accessories for arc welding, demonstrate the proper procedures to set up given shielded metallic arc (ARC) welding equipment to the instructor's standards (standards of industry or manufacturer).
21.04	(Select Electrode) Given an orientation to arc welding electrodes, select electrode and describe how to properly store and conserve electrodes during training.
21.05	(Striking and Maintaining [Substaining] and Arc [Flat Position]) Given instruction, safety protective equipment, welding machine-equipment-accessories, and electrodes, and angle iron or frame channel; strike and maintain an arc to the instructor's standards.
21.06	(Chip Slag Using Chipping Hammer) Given a welded joint and chipping hammer; remove slag from weld. Weldment must be free of all removable slag.
21.07	(Run Short Beads, Flat Position [Training Task]) Given instructions, arc welding machine, safety equipment accessories, mild steel plate, and electrode; run short beads to the instructor's standards. Flat position.
21.08	(Run Continuous Beads, Flat Position [Training Task]) Given instructions, arc welding machine-equipment-accessories (including safety clothing), electrode and metal plate; run continuous beads to the instructor's standards.
21.09	(Prepare Joint) See related task in Oxyacetylene Welding. Given metal to clean and prepare for welding, select the best joint and prepare the joint for arc welding.

21.10 (Construct Open Butt Weld, All Positions) Given a shielded metal arc welding station, mild steel coupons, electrodes, personal safety equipment, and the necessary tools and materials, construct open butt welds, 1/16 inch root opening, in all positions (flat, horizontal, vertical, and overhead). Bead must be straight and uniform in height and width; have no oxidation, weld must be fused with base metal and have full penetration.

21.11 (Construct Lap Joint Weld, 3/8 Inch Equal Legs, Three Passes) Given a shielded metal arc welding station, mild steel coupons, electrode, personal safety equipment, and the necessary tools and materials; construct a three pass lap joint weld, 3/8 inch equal legs. Beads must be straight and uniform in height and width; have a uniform ripple formation; and have no undercut porosity, craters, or oxidation. Weld must be fused with base metal and show no visible penetration on opposite side of weld.

UNIT 21.0 SHIELDED METAL-ARC WELDING (ARC WELDING)

TASK 21.01 INTRODUCTION (PRINCIPLES) OF ARC WELDING

PERFORMANCE OBJECTIVE:

Given instructions and an orientation to various welding processes, identify shielded metal arc welding as a process, describe the electric arc.

PERFORMANCE ACTIONS:

21.0101 Contrast shielded metal arc welding (SMAW) as a process compared to oxy-fuel, MIG welding processes.

21.0102 Describe the electric arc.

21.0103 Distinguish between AC and DC current.

21.0104 Describe how polarity is used in welding.

21.0105 Interpret and use the terminology of arc welding.

(NOTE: This performance action will occur during the entire training period of arc welding.)

21.0106 Describe standards for evaluation of competencies in arc welding.

PERFORMANCE STANDARDS:

- Identify SMAW as a process and interpret and use the terminology of arc welding to the standards established by the instructor.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Arc welding terminology.

ARC WELDING TERMINOLOGY

The suggested minimum terminology for arc welding is included for standardization and was taken from the following source:

Walker, John R. Arc Welding Basic Fundamentals, South Holland, IL: The Goodheart-Wilcox Company, Inc., pp. 122, 123, 1981.

AC (ALTERNATING CURRENT) - A current that reverses direction regularly as it rises and falls.

AMPERE - An electrical unit that indicates rate of flow of electricity through a circuit.

ARC LENGTH - Distance from end of electrode to surface of molten pool.

ARC VOLTAGE - Voltage across welding arc.

ARC WELDING - Process of joining metals by using heat of an electric arc, but without pressure.

BASE METAL - The metal to be welded.

BEVEL - Angle formed by a line or surface that is not at right angles to another line or surface.

BRITTLENESS - In some respects, opposite of toughness. The characteristic that causes metal to break easily.

BURR - Sharp edge remaining on metal after cutting, stamping or machining. A burr can be dangerous if not removed.

BUTT WELD - A weld made in the joint between two pieces of metal approximately in the same place.

CASEHARDENING - A process of surface hardening iron base alloys so that the surface layer or case is made substantially harder than interior or core.

CONTINUOUS WELD - A weld which extends without interruption for its entire length.

CRATER - Depression at end of a weld.

DC (DIRECT CURRENT) - Flow of electric current in one direction only.

DEPOSITED METAL - Metal that has been deposited during welding.

DEPTH OF FUSION - Distance that weld extends into base metal from its original surface.

EDGE PREPARATION - Contour prepared on edge of a member for welding.

ELECTRODE - A bare of flux coated wire or rod that is melted into base metal by an electric current passing through it.

ELECTRODE HOLDER - Device used to hold and position the electrode.

FACE OF WELD - Exposed surface of a weld, made by an arc or gas welding process, on the side from which the welding was done.

FATIGUE - Tendency for metal to break or fracture under repeated or fluctuating stresses.

FILLER METAL - Metal added to the weld.

FILLET WELD - A weld approximately triangular in shape joining two surfaces approximately at right angles to each other in a lap joint, tee joint or corner joint.

FIXTURE - A device for holding work in position or alignment while it is being welded.

FLAT POSITION - Set-up where welding is performed from upper side of joint and face of weld is approximately horizontal. Sometimes called DOWNHAND WELDING.

FLUX - Fusible material used in brazing and welding to dissolve and facilitate removal or oxides and other undesirable substances.

FUSION ZONE - Area of base metal melted as determined by inspecting cross-section of a weld.

GROOVE WELD - A weld made in groove between two members to be joined.

HARDENING - Heating and quenching of certain iron base alloys to produce a hardness superior to that of untreated material.

HORIZONTAL POSITION - Set-up where the weld is made in a horizontal plane and against an approximately vertical surface.

INCOMPLETE FUSION - A weld in which there are voids between mating parts.

INTERMITTENT WELDING - Pattern of welding where the continuity of the run is broken by unwelded spaces.

LAP JOINT - A joint between two overlapping metal pieces.

LAY OUT - To locate and scribe points for machining or forming operations.

LEG OF A FILLET WELD - Distance from root of joint to toe of fillet weld.

MALLEABILITY - Property of metal that determines ease with which it can be shaped when subjected to mechanical working (forging, rolling, etc.).

OVERHEAD POSITION - Set-up where welding is performed from the underside of the joint.

OVERLAP - Protrustion of weld metal beyond bond at toe of weld.

PASS - A single welding operation along a joint or weld deposit. A weld bead results.

PENETRATION - Distance the fusion zone extends below surface of part of parts being welded.

POROSITY - Gas pockets or voids in the metal.

PUDDLE - Portion of weld that is molten at place where heat is applied.

REVERSED POLARITY - Arrangement of arc welding leads where the work is negative pole and electrode is positive pole of arc circuit.

ROOT OF WELD - Points at which bottom of weld intersects base metal surfaces.

ROOT OPENING - Spacing or separation between metal members to be joined at the root of the joint.

SLAG INCLUSION - Nonmetallic solid material entrapped in weld metal or between weld metal and base metal.

SPATTER - Metal particles expelled during arc or gas welding which do not form a part of the weld.

STANDARD - An accepted base for a uniform system of measurement and quality.

STRING BEAD - Type of weld bead made without a weaving motion.

STRINGER BEAD - The initial bead, same as ROOT PASS.

TASK WELD - A weld (generally short) made to hold parts in proper alignment until final welds are made. Used for assembly purposes only.

UNDERCUT - A groove melted into base metal adjacent to toe of weld and left unfilled by weld metal.

UNHILL-WELDING - A pipe welding term indicating that welds are made from bottom of pipe to top of pipe. The pipe is not rotated.

VERTICAL POSITION - Set-up for welding where the axis of the weld is approximately vertical.

WEAVING - A technique of depositing metal in which the electrode is moved in an oscillating motion.

WELDING MACHINE - Equipment used to perform welding operation.

WHIPPING - An inward movement of the electrode generally employed in vertical welding to avoid undercut.

STANDARD FOR EVALUATION OF COMPETENCIES

ARC WELDING

AREA OF EVALUATION	WHAT TO LOOK FOR
1. Size of welds	
a. Stringer beads	Height and width
b. Fillet welds	Size of legs, contour of weld face
2. Starting a weld	Height and width same as rest of weld
3. Uniform flux lines	Even spacing and round shape
4. Tie-ins	Restarting a weld in a crater
5. End of weld	Proper filling of a crater at the end of the weld
6. Undercut	Groove at toes of weld
7. Excessive spatter	Small balls of metal and slag around weld area
8. Dirty welds	Improper cleaning during the after welding

UNIT 21.0 ARC WELDING

TASK 21.02 SAFETY IN ARC WELDING

PERFORMANCE OBJECTIVE:

Given instruction concerning arc welding safety, demonstrate safety precautions recommended by the instructor and text (industry standards) concerning the handling of hot metal, high current electricity, toxic fumes, large quantities of ultraviolet rays, droplets of molten metals, and proper setting of arc welding machines.

PERFORMANCE ACTIONS:

21.0201 Identify personal safety clothing and equipment.

21.0202 a. Describe personal clothing recommendations: High-top leather shoes with safety tips recommended and no canvas shoes, no cuffs in trousers and shirts without pockets recommended.
b. Identify proper safety clothing and equipment to include: Head Shield (welding helmet) or hand shield, proper lenses for ultraviolet and infrared rays and proper care of lenses, gauntlet type gloves, leather (or fire resistant) jacket, apron, or sleeves.

21.0203 a. Use tongs or pliers to handle hot metal.
b. Cool hot metal in a quench tank or safe cooling area.

21.0204 Do not carry easily ignited materials such as butane lighters, matches, etc.

21.0205 Check welding area for proper ventilation.

21.0206 Check welding area to ensure the safety of others. Check to ensure safe housekeeping.

21.0207 Check to ensure the equipment and accessories are safe before starting.

PERFORMANCE STANDARDS:

- Demonstrate by written knowledge test and performance in training situations, proper safety precautions for arc welding, meeting the instructor's standards and standards accepted by the welding industry.
- "Zero" reportable injuries.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Proper care with flammable material around welding shop.
- Take care in damp or wet areas.
- Proper care in welding a tank or container, especially if it has contained flammable material in the past.

Addendum to Task 21.02

SAFETY IN ARC WELDING

The following "safety cautions" are quoted directly from the following publication and are recommended as a safety standard in arc welding training.

Giachino, Joseph W., Weeks, William. Welding Skills and Practices, Chicago, IL: American Technical Publishers, Inc., pp. 14-17, 1976.

1. "Install welding equipment according to provisions of the National Electric Code.
2. "Be sure a welding machine is equipped with a power disconnect switch which is conveniently located at or near the machine so the power can be shut off quickly.
3. "Don't make repairs to welding equipment unless the power to the machine is shut OFF.
4. "Don't use welding machines without proper grounding. Do not ground to pipelines carrying gases or flammable liquids.
5. "Don't use electrode holders with loose cable connectors. Keep connections tight at all times. Avoid using electrode holders with defective jaws or poor insulation.
6. "Don't change the polarity switch when the machine is under a load: Wait until the machine idles and the circuit is open.
7. "Don't operate the range switch under load. The range switch which provides the current setting should be operated only while the machine is idling and the current is open.
8. "Don't overload welding cables or operate a machine with poor connections.
9. "Don't weld in damp areas and keep hands and clothing dry at all times. Dampness on the body may cause an electric shock. Never stand or lie in puddles of water, on damp ground, or against grounded metal when welding without suitable insulation. Use a dry board or rubber mat to stand on.
10. "Don't strike an arc if someone without proper eye protection is nearby. Arc rays are harmful to the eyes and skin. If other persons must work nearby, the welding area should be partitioned off with a fire-retardant canvas curtain to protect them from the arc welding flash. (See item 17)
11. "Never pick up pieces of metal which have just been welded or heated.

12. "Always wear protective eye goggles when chipping or grinding.

13. "Don't weld on hollow (cored) casting unless they have been properly vented, otherwise an explosion may occur.

14. "Be sure press-type welding machines are effectively guarded.

15. "Be sure suitable spark shields are used around equipment in flash welding.

16. "When welding is completed, turn OFF the machine. If applicable, pull the power disconnect switch. Hang the electrode holder in its designated place."

17. Wear contact lenses around welding operatiors with caution and do not expose the eye and lens to an ARC (the plastic lens may fuse to the eye).

TASK 21.03 MACHINES AND ACCESSORIES

PERFORMANCE OBJECTIVE:

Given instruction concerning machines and accessories for arc welding, demonstrate the proper procedures to set up given shielded metallic arc (ARC) welding equipment to the instructor's standards (standards of industry or manufacturer).

PERFORMANCE ACTIONS:

21.0301 Identify basic types of arc welding machines:

a. (1) AC
   (2) DC
   (3) AC/DC Rectifier

b. Interpret advantages/uses of each type.

21.0302 Locate major controls on different machines in training lab.

21.0303 Identify arc welding equipment accessories:

a. Cables
b. Ground clamp
c. Electrode holder
d. Electrodes
e. Welding shield or helmet
f. Personal safety clothing
g. Hot metal handling tools
h. Weld cleaning equipment

21.0304 Demonstrate proper procedures for setting up arc welding equipment.

PERFORMANCE STANDARDS:

- Set up arc welding equipment according to instructor's guidelines according to the type of welding to be done.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Safety precautions in operating machines.
- Manufacturer's instructions.

Addendum to Task 21.03

ARC WELDING EQUIPMENT

CHECKLIST

Check each item prior to starting any welding assignment. (The checklist may be used by the student or instructor.)

Yes	No		
( )	( )	1.	Machine is grounded properly.
( )	( )	2.	Cable ground clamp is secured properly.
( )	( )	3.	Main power switch is turned on for welding.
( )	( )	4.	The machine, of a motor generator, is set for correct polarity.
( )	( )	5.	The amperage control is set at the approximate current for the electrode to be used.
( )	( )	6.	The electrode holder is in good condition.
( )	( )	7.	The bench top is clean and dry.
( )	( )	8.	Welding gloves are available for use.
( )	( )	9.	Trainee is wearing proper protective clothing for welding.
( )	( )	10.	Clear cover glasses over the helmet lens are relatively free of metal spatter.
( )	( )	11.	The welding area is shielded properly.
( )	( )	12.	There is ample ventilation.
( )	( )	13.	Slag removal equipment is available.

Source: Giachino, Joseph W. Arc Welding, Alsip, IL: American Technical Publishers, Inc., 1977.

UNIT 21.0 ARC WELDING

TASK 21.04 SELECT ELECTRODE

PERFORMANCE OBJECTIVE:

Given an orientation to arc welding electrodes, select electrode and describe how to properly store and conserve electrodes during training.

PERFORMANCE ACTIONS:

21.0401 Describe the actions of electrodes in arc welding.

21.0402 Identify arc welding electrodes given by instructor.

21.0403 Explain how to properly store electrodes.

21.0404 Describe how to conserve electrodes in training.

21.0405 Demonstrate proper selection of electrodes for given welding jobs.

PERFORMANCE STANDARDS:

- Describe how to properly store electrodes and how to conserve electrodes in training.
- Demonstrate proper selection of electrodes, storage, and conservation.

SUGGESTED INSTRUCTION TIME: Optional training

UNIT 21.0 ARC WELDING

TASK 21.05 STRIKING AND MAINTAINING (SUBSTAINING) AN ARC (FLAT POSITION)

PERFORMANCE OBJECTIVE:

Given instruction, safety protective equipment, welding machine-equipment-accessories, and electrodes, and angle iron or frame channel; strike and maintain an arc to the instructor's standards.

PERFORMANCE ACTIONS:

21.0501 Prepare for welding. (Take safety precautions included.)

21.0502 Set up given arc machine-equipment-accessories.

21.0503 Position metal.

21.0504 Correctly position electrode in holder and grip holder for welding.

21.0505 a. Strike and maintain an arc. (Use scratch, tapping, etc., method to produce acceptable arc.)
b. Adjust for proper heat.

PERFORMANCE STANDARDS:

- Strike and maintain an arc to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Operation of arc machine-equipment-accessories.
- Safety precautions.
- Electrode identification.

Addendum to Task 21.05

WELDING ANALYSIS

CHECKLIST

Yes	No	
( )	( )	1. Bead width are right size.
( )	( )	2. Beads have uniform ripples.
( )	( )	3. Weld beads are too flat.
( )	( )	4. Weld beads are too high.
( )	( )	5. Weld penetration is insufficient.
( )	( )	6. Weld penetration is excessive.
( )	( )	7. Cold laps on surface.
( )	( )	8. Weld has surface porosity.
( )	( )	9. Weld has subsurface porosity.
( )	( )	10. Weld has crater cracks.
( )	( )	11. Weld has burn thru.
( )	( )	12. End crater is filled.
( )	( )	13. Weld passes bend test without cracking.

Source: Giachino, Joseph W. Arc Welding, Alsip, IL: American Technical Publishers, Inc., 1977.

UNIT 21.0 ARC WELDING

TASK 21.06 CHIP SLAG USING CHIPPING HAMMER

PERFORMANCE OBJECTIVE:

Given a welded joint and chipping hammer; remove slag from weld. Weldment must be free of all removable slag.

PERFORMANCE ACTIONS:

21.0601 Prepare for chipping: Select safety equipment.

21.0602 Select chipping hammer.

21.0603 Chip slag from weld using side by side method.

21.0604 Brush to clean as required.

PERFORMANCE STANDARDS:

- Chip slag from freshly cooled weld so that all removable slag is freed.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Clean weld area thoroughly of all paint, scale, rust, etc.
- Uncleaned weld are is the common cause of slag.

UNIT 21.0 ARC WELDING

TASK 21.07 RUN SHORT BEADS, FLAT POSITION (TRAINING TASK)

PERFORMANCE OBJECTIVE:

Given instructions, arc welding machine, safety equipment, accessories, mild steel plate, and electrode; run short beads to the instructor's standards. Flat position.

PERFORMANCE ACTIONS:

21.0701 Prepare for arc welding (including safety precautions).

21.0702 Set up arc machine-equipment-accessories.

21.0703 Position plate.

21.0704 a. Run short beads in flat position to instructor's standards. (Scratch method recommended).
b. Examine weld bead (after each pass).
c. Adjust machine as necessary to produce a satisfactory bead.

21.0705 Clean weld after each pass.

PERFORMANCE STANDARDS:

- Run short beads to instructor's standards.
- Beads must be straight, with no undercut, no slag inclusions or porosity.
- Even ripple appearance.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Recognizing the sound of an arc that is:
  a. correct (continuous cracking, frying)
  b. too long (humming)
  c. or too short (popping)
- Identify desired puddle appearance.
- Check adjustment of welding heat.

UNIT 21.0 ARC WELDING

TASK 21.08 RUN CONTINUOUS BEADS, FLAT POSITION
(TRAINING TASK)

PERFORMANCE OBJECTIVE:

Given instructions, arc welding machine-equipment-accessories (including safety clothing), electrode and metal plate; run continuous beads to the instructor's standards.

PERFORMANCE ACTIONS:

21.0801 Prepare for arc welding. (Machine safety equipment, accessories, personal safety, etc.)

21.0802 Mark lines on steel plate and position plate for welding.

21.0803 Run a continuous bead, starting at left edge of work, using the full length of the electrode.

21.0804
a. Remove slag.
b. Examine weld.
c. Adjust machine if necessary.

Suggested: At end of weld, stop bead by shortening arc and quickly backing or "whipping" electrode to break the arc.

(NOTE: Running a continuous bead will be repetitive process until the student becomes competent in the task.)

ADDITIONAL SKILL DEVELOPMENT TASKS IN RUNNING BEADS

1. Practice re-striking the arc while running continuous beads.
2. Practice padding.

PERFORMANCE STANDARDS:

- Run a continuous bead on given metal plate to the instructor's standards.
- Even ripple appearance.
- No undercut, porosity, slag inclusions.
- Proper penetration.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Proper use of electrode in striking the arc.

UNIT 21.0 ARC WELDING

TASK 21.09 PREPARE JOINT

PERFORMANCE OBJECTIVE:

(See related task in Oxyacetylene Welding) Given metal to clean and prepare for welding, select the best joint and prepare the joint for arc welding.

PERFORMANCE ACTIONS:

21.0901 Select type of joint. (It should be simplest joint to adequately do the job.)

21.0902 Prepare the joint so that the weld may penetrate close to 100 percent (deep penetration).

21.0903
a. Square butt.
b. Single bevel groove.
c. Single V groove.

21.0904 Clean and dry joints for welding.

PERFORMANCE STANDARDS:

- Prepare joints for welding meeting instructor's standards.

SUGGESTED INSTRUCTION TIME: Optional training

RELATED TECHNICAL INFORMATION:

- Review related task in Oxyacetylene Welding, as necessary.
- Metal characteristics.

UNIT 21.0 ARC WELDING

TASK 21.10 CONSTRUCT OPEN BUTT WELD, ALL POSITIONS

PERFORMANCE OBJECTIVE:

Given a shielded metal arc welding station, mild steel coupons, electrodes, personal safety equipment, and the necessary tools and materials, construct open butt welds, 1/16 inch root opening, in all positions (flat, horizontal, vertical, and overhead). Bead must be straight and uniform in height and width; have no oxidation, weld must be fused with base metal and have full penetration.

PERFORMANCE ACTIONS:

21.1001 Prepare for ARC welding; select safety equipment.

21.1002 Set up SMAW machine, equipment, and supplies, and overhead fixture (jig) as applicable.

21.1003 Clean and position plate in proper configuration and position.

21.1004 Tack weld plates into position.

21.1005 Construct open butt weld, all positions, to specifications.

PERFORMANCE STANDARDS:

- Construct open butt weld, all positions, to specifications, so that the bead is straight and uniform in height and width, there is no oxidation, the weld is fused with base metal, and there is full penetration.
- The instructor's standards must be met.

SUGGESTED INSTRUCTION TIME: Optional training

UNIT 21.0 ARC WELDING

TASK 21.11 CONSTRUCT LAP JOINT WELD, 3/8 INCH EQUAL LEGS, THREE PASSES

PERFORMANCE OBJECTIVE:

Given a shielded metal arc welding station, mild steel coupons, electrode, personal safety equipment, and the necessary tools and materials; construct a three pass lap joint weld, 3/8 inch equal legs. Beads must be straight and uniform in height and width; have a uniform ripple formation; and have no undercut, porosity, craters, or oxidation. Weld must be fused with base metal and show no visible penetration on opposite side of weld.

PERFORMANCE ACTIONS:

21.1101 Prepare for ARC welding.

21.1102 Set up SMAW machine, equipment, and supplies, and (jig), as applicable.

21.1103 Clean and position plate in proper configuration, position.

21.1104 Tack weld.

21.1105 Make multiple passes to weld lap joint as specified.

PERFORMANCE STANDARDS:

- Construct lap joint weld, 3/8 inch equal legs, three passes.
- Beads must be straight and uniform in height and width; have a uniform ripple formation; and have no undercut, porosity, craters, or oxidation.
- Weld must be fused with base metal and show no visible penetration on opposite side of weld.

SUGGESTED INSTRUCTION TIME: Optional training

CHECKLIST FOR SMAW WELDS

CHECK TO INDICATE THAT THE STUDENT HAS COMPLETED THE WELD TO INDUSTRY STANDARDS (Omit otherwise)

	Flat	Horizontal	Vertical
1. Even bead.			
2. Even ripples in bead.			
3. Bead uniform in width.			
4. Bead height not excessive.			
5. No holes in weld.			
6. Weld not brittle.			
7. No excessive metal under joint.			
8. Proper penetration.			
9. No cracks.			
10. End crater filled.			
11. No cold overlaps along joint seam.			
12. Good fusion.			
13. No undercutting.			
14. No porosity.			

PROFICIENCY REPORT

PROFICIENCY REPORT
for

____
Vocational Course

Student: ________________________

High School: ________________________

Career Center: ________________________

Date Training Initiated: __________
First Year Completed: __________
Second Year Initiated: __________
Second Year Completed: __________

Instructor: ________________________

DIRECTIONS: The purpose of the proficiency report is to communicate to the student, other instructors, or potential employers the abilities that a student has demonstrated to the instructor in vocational training. Mark each task as soon as possible after instruction or skills demonstrated. If instruction is not aimed as task proficiency, or if only an orientation or introduction to the task was provided, DO NOT mark a proficiency level or mark Level 0. Levels 1-4 indicate that instruction was given and the proficiency may be interpreted as follows:

Level 0	No skill level demonstrated or proficiency training not given in the skill.
Level 1	Individual's skill level is not that generally expected for entry level employment.
Level 2	Individual's skill level probably is that generally expected for entry level employment, but the individual probably will need close on-the-job supervision for a while longer.
Level 3	Individual's skill level is that generally expected for entry level employment.
Level 4	Individual's skill level is equal to that of a worker with some on-the-job experience.

For further description of the levels of proficiency, see the "Credentialing Process and Proficiency Report" section of the Policies and Procedures Guide for Articulation Between The School District of Greenville County and Greenville Technical College.

STUDENT ______________________________

PROFICIENCY REPORT

MACHINE SHOP

			Proficiency Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
UNIT	1.0	INTRODUCTION						
UNIT	1.0 B	INTRODUCTION TO SAFETY						
	1.03-1.05	Observed and Applied Safety Rules, Procedures, and Practices						
UNIT	1.0 C	INTRODUCTION TO LEADERSHIP/ JOB COMMUNICATIONS						
	1.01	Worked Cooperatively With Fellow Students						
UNIT	1.0 E	INTRODUCTION TO DESIRABLE JOB/LEARNING CHARACTERISTICS/ HABITS/ATTITUDES						
	1.01	Displayed Good Work Habits Important to Job Success						
	1.02	Exhibited Successful Job Performance Characteristics						
	1.03	Exhibited Desirable Work Attitudes						
UNIT	1.0 F	ACCEPTABLE BASIC MATH SKILLS						
UNIT	1.0 G	ACCEPTABLE BASIC MEASURING SKILLS						
UNIT	1.0 H	ACCEPTABLE INTRODUCTORY BLUEPRINT READING						
	1.02	Reads Dimensions and Tolerances						
UNIT	1.0 I	CAN WRITE AND READ TECHNICAL INFORMATION CONCERNING MACHINING OPERATIONS						
UNIT	2.0	USING PRECISION MEASURING INSTRUMENTS						
	2.02	Able to Layout Workpiece on Surface Plate						
	2.03	Able to Layout Workpiece With Combination Square						
	2.04	Able to Layout Workpiece With Hemaphrodite Calipers						
	2.05	Measured Workpiece With 6 Inch Pocket Scale						
	2.06	Measured Workpiece With Tape Measure						
	2.07	Measured Workpiece on Surface Plate						
	2.08	Checked Workpiece With Sine Bar						

			Proficiency					
			Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
	2.09	Checked Workpiece Using Radius Fillet or Center Gages						
	2.10	Measured Inside Diameters With Venier Caliper						
	2.11	Measured Workpiece With Depth Gages						
	2.12	Measured Workpiece With Depth Micrometer						
	2.13	Measured Workpiece With Dial Calipers						
	2.14	Measured Workpiece With Gage Blocks						
	2.15	Measured Workpiece With Vernier Height Gage						
	2.16	Measured Workpiece With Inside Micrometer						
	2.17	Measured Workpiece With Telescope and Hole Gages						
	2.18	Measured Workpiece With Thread Wires						
	2.19	Transferred Dimensions With Divider						
	2.20	Measured Outside Diameter With Outside Calipers						
	2.21	Measured Round Stock With Outside Micrometer						
	2.22	Measured With Inside Caliper						
	2.23	Measured Threads Per Inch With Screw Pitch Gage						
	2.24	Measured Screw Threads With Screw Thread Micrometer						
	2.25	Described Optical Comparator						
	2.26	Checked Round Stock With Dial Indicator						
	2.28	Used Radius Gage						
UNIT	3.0	ABLE TO LAYOUT TYPICAL MACHINE SHOP JOBS; INCLUDING BOLT CIRCLES, COMPOUND ANGLES, AND TANGENTS						
UNIT	4.0	BENCHWORK						
	4.01	Inspected Workbench Area for Safe Working Environment						
	4.02	Cared for Hand Tools						
	4.03	Bench Filed Workpiece						
	4.04	Disassembled/Assembled Workpiece With Arbor Press						
	4.05	Hand Broached an Internal Keyway						

			Proficiency					
			Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
	4.06	Using Hand Hacksaw, Cut Given Material in Required Time						
	4.07	Cut Threads With Hand Tap						
	4.08	Drilled Holes With Portable Drill						
	4.09	Correctly Used Hand Grinder						
	4.10	Hand Honed Cutting Tools						
	4.11	Hand Reamed Holes						
	4.12	Removed Broken Drills and Taps						
	4.13	Removed Damaged/Broken Studs/Screws						
	4.14	Cut Threads With Die						
	4.15	Filed Test Workpiece for Hardness						
	4.16	Removed Frozen or Seized Parts						
	4.17	Identified Types of Fasteners						
	4.18	Assembled and Fitted Parts						
	4.19	Identified and Properly Used Work-holding Devices and Set ups						
	4.20	Identified and Properly Used Coolants and Cutting Compounds						
	4.21	Properly Used Hand Tools and Assembly/Disassembly						
UNIT	5.0	BASIC GRINDING (BENCH AND PEDESTAL GRINDERS)						
	5.01	Set-up Pedestal Grinder						
	5.03	Ground a Convex Radius						
	5.04	Ground a Center Punch						
	5.05	Sharpened a Chisel						
UNIT	6.0	DRILL PRESS						
	6.02	Set Up a Drill Press						
	6.03	Drilled Holes to Size						
	6.04	Counterbored Hole to Specifications						
	6.05	Countersunk Hole to Specifications						
	6.06	Reamed Hole to Size						
	6.07	Spot Faced to Specified Dimensions						
	6.08	Mounted Work on V-blocks						
	6.09	Tapped Hole With Tapping Attachment						
UNIT	7.0	POWER SAWS						
	7.02	Cut and Welded Bandsaw Blade						
	7.03	Replaced Bandsaw Blade						
	7.04	Sawed Internal Contours With Bandsaw						
	7.05	Sawed to Scribed Line						
	7.06	Selected and Set Speeds and Feeds for Sawing Operations						

			Proficiency Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
	7.07	Made Straight and Angular Cuts With Power Saw						
	7.08	Cut Material to Length With Power Hacksaw						
UNIT	8.0	BASIC ENGINE LATHE WORK						
	8.02	Set Up Engine Lathe for Turning Operations						
	8.03	Aligned Lathe Centers Using Accurate Measurement Techniques						
	8.04	Mounted Workpiece Between Centers						
	8.05	Aligned Workpiece on Faceplate						
	8.06	Aligned Workpiece in Four-Jaw Chuck						
	8.07	Made Roughing Cuts						
	8.08	Made Finishing Cuts						
	8.09	Turned a Workpiece to Dimensions						
	8.10	Faced a Workpiece to Dimensions						
	8.11	Knurled a Workpiece						
	8.12	Drilled Holes With Lathe						
	8.13	Reamed Holes on the Lathe						
	8.14	Bored Holes						
	8.15	Counterbored Holes						
	8.16	Countersunk Holes Using the Lathe						
	8.17	Tapped Holes						
	8.18	Cut Grooves or Recess						
	8.19	Machined External Chamfer						
	8.20	Machined Internal Chamfer						
	8.21	Parted Workpieces						
	8.22	Filed Workpieces						
	8.23	Polished Workpieces						
UNIT	9.0	BASIC AND ADVANCED MILL WORK						
	9.01	Inspected and Cleaned a Milling Machine						
	9.02	Identified Milling Machine Work Holding Devices and Their Functions						
	9.03	Aligned Workpiece Mounted on Machine Table						
	9.04	Aligned Mill Head to Table						
	9.05	Aligned Milling Machine Attachments						
	9.06	Aligned Milling Machine Fixtures and Indicator						
	9.07	Calculated Cutting Speeds and Feeds for Milling Machine Work						
	9.08	Faced Mill Workpiece						
	9.09	Performed Side Milling Operation						
	9.10	Performed Angular Milling Operation						

		Proficiency					
		Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
9.11	Performed End Milling Operation						
9.12	Drilled, Bored, and Reamed Holes						
9.13	Performed Keyseating and T-Slot Milling Operation						
9.14	Cut Slots With Milling Machine (Slitting Operation)						
9.15	Performed Indexing Operations						
9.16	Performed Graduating and Marking Operations						
9.17	Identified Types of Gears and Their Functions						
9.18	Calculated Pitch, Diameters, Working Depth and Clearances for Machining Gears						
9.19	Milled a Gear Rack						
9.20	Machined a Spur Gear						
UNIT 10.0	ADVANCED BLUEPRINT READING IN MACHINING						
10.01	Interpreted Sectional Views						
10.02	Determined Metric Dimensions and Tolerances from Blueprint Data						
10.03	Interpreted Auxiliary Views						
10.04	Sketched Shop Drawings of Workpiece to be Machined						
10.05	Interpreted Assembly Drawings						
10.06	Interpreted an Assembly Drawing Bill of Materials						
UNIT 11.0	TURRET LATHE						
11.01	Identified Turret Lathe						
11.02	Cleaned and Lubricated the Turrent Lathe						
11.03	Identified Work Holding Devices						
11.04	Identified Chucking Operations on the Turret Lathe						
11.05	Identified Standard Tool Holding Devices for Turret Lathe						
11.06	Selected Cutting Speed and Feed						
11.07	Identified Coolants						
UNIT 12.0	SURFACE GRINDER						
12.01	Inspected and Cleaned a Surface Grinder						
12.02	Set Up Surface Grinder for Flat Surface Operation						
12.03	Able to Grind Flat Surfaces						

		Proficiency Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
UNIT 13.0	SHAPER						
13.03	Set Up Shaper for Machining Operations, Set Speed and Feed						
13.04	Made a Rough and Finished Horizontal Cut						
13.05	Able to Shape Flat Surfaces						
13.06	Able to Shape Angular Surfaces						
UNIT 14.0	TOOL AND CUTTER GRINDER						
14.02	Set Up a Tool and Cutter Grinder						
14.03	Sharpened Drill Bits						
UNIT 15.0	HEAT TREATMENT						
15.01	Tested Workpiece for Hardness						
15.02	Able to Anneal Workpiece						
15.03	Hardened and Tempered a Workpiece						
15.04	Hardened Given Small Tools						
UNIT 16.0	THE HYDRAULIC PRESS						
16.02	Straightened Parts With Hydraulic Press						
16.03	Removed and Replaced Parts Using Hydraulic Press						
UNIT 17.0	COMPUTER NUMERCIALLY CONTROLLED (CNC) MACHINING						
17.01	Identified the Controls and Operations of the Emco Compact 5 CNC Trainer						
17.03	Able to Plot CNC Drawing for Coordinates						
17.04	Able to Calculate Coordinates and Dimensions of CNC Drawing						
17.05	Able to Write Program for CNC Machine						
17.06	Set Up CNC Program/Machine						
17.07	Machined Workpiece With CNC Machine						
UNIT 18.0	MACHINING MATH CALCULATIONS						
18.01	Calculated Amount of Stock Required for Machining Job						
18.02	Converted Revolutions Per Minute or Grinding Wheel to Surface Feet Per Minute						
18.03	Calculated Depths and Widths of Slots and Grooves on Special Set Ups						
18.04	Calculated Feeds and Speeds						
18.05	Calculated for Angular and Simple Indexing						

		Proficiency					
		Level 0	Level 1	Level 2	Level 3	Level 4	Date Completed
18.06	Calculated Gear Blank Specifications						
18.07	Calculated Sine-Bar Dimensions for Machine Shop						
18.08	Calculated Tap Drill Size With Formula						
18.09	Calculated Tapers for Machine Shop						
18.10	Calculated Tolerance/ Allowances						
18.11	Converted Common Fractions to Decimal Fractions						
18.12	Converted Dimensions to Metric Size						
UNIT 19.0	MACHINE SHOP PROJECTS/ LIVE WORK (DESCRIBE SKILLS DEVELOPED)						

COMMENTS:

INSTRUCTOR

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ADDITIONAL REFERENCES

(Secondary Machine Shop)

Reference 1	DACUM Matrix for Machinist, SC
Reference 2	DACUM Matrix for NC Operator, Greenville, SC
Reference 3	Suggested Skills: Machinsit, Grinder Operator, Drill Press Operator, Lathe Operator, Milling Machine Operator
Reference 4	Survey of Secondary Level Lab Facilities
Reference 5	Recommended Secondary Level T & I Equipment

Reference 1 DACUM Matrix for Machinist, SC

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Horry-Georgetown Technical College

MAY, 1983

A DACUM MATRIX OF OCCUPATIONAL COMPETENCIES

A MACHINIST: READ AND INTERPRET A BLUEPRINT AND PRODUCE A FINISHED PART AS PER SPECIFICATIONS

A. INDIVIDUAL SAFETY PRACTICES	A-1 Recognize machine hazards	A-1a Check for proper fixturing and clamping	A-1b Recognize if machine is properly functioning	A-1c Keep equipment clean	A-1d Keep work area clean	A-1e Show care and safety for other individuals
		A-1f Prohibit horseplay around machinery				
	A-2 Personal safety	A-2a Wear eye protection	A-2b Wear proper clothing and foot wear (attire)	A-3c Recognize if machine operator is under emotional/medicinal influence		
B. PRECISION MEASURING INSTRUMENTS	B-1 Use micrometers and calipers to measure inside and outside diameter	B-2 Use micrometers, calipers and scales to measure lengths	B-3 Use protractors to measure angles	B-4 Read vernier scale for measurements	B-5 Use bore gages, telescoping gages and tri-mics for measuring inside diameters	
	B-6 Use squares, scales, and scribes for layout	B-7 Use dial indicators	B-8 Use height gage and surface place for layout, measuring heights and dimension	B-9 Use fixed gages, i.e., plug, radius thread, snap, go-no-go	B-10 Use a comparator for checking profiles	B-11 Use precision gage blocks
	B-12 Use sine bars (angles)	B-13 Use digital readout for productive measuring				
C. HAND TOOLS	C-1 Identify and properly use wrenches, files, screwdrivers, center punching, pliers, electric hand tools, grinders, hand drills, saws, hammers, hacksaws, vise grips, parallel clamps, small precision vise, V-blocks, etc.				C-2 Clean tools	C-3 Store and maintain tools
D. DRAW AND INTERPRET BLUEPRINTS	D-1 Draw objects in orthographic and isometric projections	D-2 Interpret orthographic and isometric projections	D-3 Use mechanical drawing techniques	D-4 Dimension and tolerance drawings	D-5 Detect error on drawings	D-6 Evaluate the economic and proper procedure for manufacturing

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	D-7 Read manufacturer's catalog	D-8 Translate and interpret manufacturer's code to eliminate drawing details (blueprint)		D-9 Operate a blueprint machine	D-10 Interpret manufacturing notes and specifications	D-11 Work to a sample
E. OPERATE MACHINE TOOLS	E-1 NC and CNC Lathes	E-1a Program machine for threading, turning, boring, center drilling, drilling, tapping, etc.		E-1b Identify and specify its uses	E-1c Select speeds and feeds	E-1d Use flexowriter and computer assisted program method
		E-1e Select proper tools: inserts, profiles, brazed inserts, spade drills, step drills, end mills.		E-1f Identify and properly use carbide inserts	E-1g Identify and select proper coolant	
						E-1-100 Maintain equipment (daily lubrication)
	E-2 Production Lathes	E-2a Select feeds and speeds	E-2b Visually inspect set-up and machine	E-2c Identify and specify the uses of a turret lathe	E-2d Select proper tools: die heads, taps, and step reams	E-2e Identify and properly use carbide inserts
		E-2f Identify and specify proper coolant				E-2-100 Maintain equipment (daily lubrication)
	E-3 Toolroom Lathes	E-3a Select the proper tools for the job	E-3b Prepare the tool (grinding)	E-3c Select feeds and speeds	E-3d Perform turning, facing, and boring	E-3e Perform threading, grooving and cut off
		E-3f Operate and set-up tool post grinder	E-3g Perform tapering and eccentric turning	E-3h Perform center drilling, drilling, reaming and tapping	E-3i Perform knurling	E-3j Identify and select proper coolant

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E. (continued)

OPERATE MACHINE TOOLS

					E-3-100 Maintain equipment (daily lubrication)
E-4 NC and CNC Milling Machine	E-4a Program machine to do face milling, side milling, fly cutting, boring, center drilling, drilling, tapping, sawing, profiling, radius milling		E-4b Use a flexowriter and computer assisted program methods	E-4c Select feeds and speeds	E-4d Identify and specify its uses
	E-4e Use edge finder or wiggler to find reference point	E-4f Use dial indicator	E-4g Select proper tooling	E-4h Indicate the vise and set-up tooling	E-4i Identify and select proper coolant
					E-4-100 Maintain equipment (daily lubrication)
E-5 Horizontal Milling Machine	E-5a Select feeds and speeds	E-5b Select the proper tooling	E-5c Identify and select proper coolant	E-5d Perform slab, straddle, gang, slitting, slotting, and boring	E-5e Make spur gears and bevel gears
					E-5-100 Maintain equipment (daily lubrication)
E-6 Vertical Milling Machine	E-6a Select feeds and speeds	E-6b Identify and select proper coolant	E-6c Perform face milling, side milling, fly cutting, boring center drilling, drilling, tapping, sawing, profiling, radius milling		
	E-6d Use rotary table and dividing head	E-6e Use digital readout	E-6f Perform slitting and slotting	E-6g Identify quick change tooling	E-6h Use edge finder or wiggler to pick up centers or reference points

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E. (continued) OPERATE MACHINE TOOLS		E-6i Use dial indicator	E-6j Indicate the head and the vise	E-6k Select proper tooling	E-6l Use centering scope	E-6m Identify accessories and its uses: slotting attachment, high speed attachment, righ angle head
		E-6n Perform counterboring and countersinking	E-6o Use locating stops			E-6-100 Maintain equipment (daily lubrication)
	E-7 Grinding Machines	E-7a Select speeds and feeds (for manual or automatic grinders)	E-7b Identify and select proper coolant	E-7c Identify and use grinding wheels by shape and compostion	E-7d Inspect a wheel using the ring method	E-7e True and dress a wheel
		E-7f Grind carbide using a diamond or silicon wheel	E-7g Grind tool steel with aluminum oxide and borazon wheel	E-7h Grind nonferrous metal with vitrified wheel	E-7i Grind nonmetalic material with soft wheel	E-7j Use a surface grinder to grind flat surface and radii
		E-7k Identify specific use of an universal and tool grinder	E-7l Perform OD and ID grinding using cylindrical universal, tool post, internal and surface grinders		E-7m Use abrasive cut off wheel	E-7n Use bench grinder to sharpen tools
						E-7-100 Maintain equipment (daily lubrication)
	E-8 Sawing	E-8a Select speeds and feeds	E-8b Identify and select proper coolant	E-8c Select proper pitch of saw blade	E-8d Weld saw blades	E-8e Cut stock to length using band saw
		E-8f Cut contours and shapes using a vertical band saw	E-8g Cut stock to length using circular saw and abrasive saw	E-8h Cut stock to length using horizontal band saw and reciprocating saw		E-8-100 Maintain equipment (daily lubrication)

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(continued) OPERATE MACHINE TOOLS	E-9 Drills	E-9a Select speeds and feeds	E-9b Identify and select proper coolant	E-9c Center drill, drill, tap and ream on a drill press	E-9d Center drill, drill, tap and ream on a radial drill	E-9e Identify and specify special drilling machines, multiple spindle gang, deephole, etc.
		E-9f Perform counterboring and countersinking	E-9g Sharpen drills			E-9-100 Maintain equipment (daily lubrication)
	E-10 Jig Boring Machines	E-10a Analyze print for proper procedure	E-10b Prepare coordinate charts	E-10c Select speeds and feeds	E-10d Select the proper tooling	E-10e Identify and select proper coolant
		E-10f Use the digital read out	E-10g Perform multiple hole precision drilling and boring	E-10h Use centering scope to locate centers and edges	E-10i Use tilting rotary table	
						E-10-100 Maintain equipment (daily lubrication)
USE SHOP MATH	F-1 Manipulate fractions and decimals	F-2 Make unit conversions (metric and English)	F-3 Layout angles, lines and circles	F-4 Calculate for X and Y coordinates	F-5 Solve angle formulas	F-6 Solve simple equatios (speeds and feeds) horsepower and requirements
COMMUNICATION SOCIAL SKILLS	G-1 Read technical literature	G-2 Write technical reports	G-3 Follow company policies and prodcedures (promptness, attendance)	G-4 Display good manners	G-5 Dress properly for the job	G-6 Accept constructive criticism
	G-7 Use diplomacy	G-8 Maintain a pleasant attitude	G-9 Be willing to give constructive advice	G-10 Be willing to assist fellow workers	G-11 Be willing to admit your short comings	G-12 Be resourceful (improvise)

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DACUM PANEL:

John Hardee
Grove Manufacturing Co.
Conway, SC

Joey Bledsoe
Grove Manufacturing Co.
Conway, SC

Frank Pate
AVX
Myrtle Beach, SC

Timmy Barfield
Wolverine Brass Co.
Conway, SC

Ken Tevebaugh
Advanced Engineering
North Myrtle Beach, SC

Robert Domian
Radcar Metals
North Myrtle Beach, SC

H. WELDING	H-1 Perform basic flat procedures	H-2 Perform stick welding	H-3 Perform silver solder and brazing	H-4 Perform mig welding	H-5 Perform flame cut	H-6 Perform plasma cut
	H-100 To perform tig welding	H-101 Perform inter-shield welding	H-102 Perform induction welding	H-103 Perform spot welding		
I. METALLURY	I-1 Recognize different types of metals	I-2 Identify properties of metals according to their standard classification	I-3 Perform a spark test	I-4 Perform basic heat treating	I-5 Be familiar with heat affects on metal	I-6 Use a hardness tester (Brindell, Rockwell)
	I-7 Perform case hardening	I-8 Perform flame hardening	I-9 Identify and properly use carbide material	I-10 Anneal metals	I-11 Use induction hardening	I-12 Relate machine-ability to speeds and feeds
	I-100 Select materials based on application	I-101 Identify and use non-metalic materials				
J. QUALITY CONTROL	J-1 Do in-process inspection and final inspection	J-2 Inspect parts to required inspection levels	J-3 Perform calibration adjustment to measuring instruments			

DACUM PANEL: (continued)

Louis Rossi
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DACUM FACILITATOR:

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Reference 2   DACUM Matrix for NC Operator, Greenville SC

A DACUM MATRIX OF OCCUPATIONAL COMPETENCIES

NUMERICAL CONTROL OPERATOR: Sets up, operates, and recognizes problems in the machine tool* process, program and equipment.

GREENVILLE TECHNICAL COLLEGE
NOVEMBER 11-13, 1981

A. Basic knowledge and use of machine types	A-1 Turning	A-2 Boring	A-3 Milling	A-4 Drilling	A-5 Grinding	A-6 Forming
B. Mathematics	B-1 Demonstrates use of metric system	B-2 Apply procedures of Geometry	B-3 Apply principles of trigonometry			
C. Blueprints: Reading and interpreting	C-1 Interpret basic views	C-2 Interpret basic dimensions	C-3 Understand the tolerances of the basic dimensions	C-4 Calculate basic dimensions where tolerancing not bi-lateral	C-5 Interpret Geometrical tolerances	
D. Measurement Devices	D-1 Identify, select and use appropriate gage	D-2 Read micrometers	D-3 Read Vernier Caliper	D-4 Use dial and electronic indicators	D-5 Use dial bore gages	D-6 Use plug gages
	D-7 Use snap gages	D-8 Use thread gages	D-9 Use gage blocks	D-10 Read/use optical communicator	D-11 Inspect surface finish	D-12 Use height gages
E. Set-up Skills	E-1 Read and follow instructions	E-2 Follow a routing sheet (sequence of operations)	E-3 Demonstrate safety procedures	E-4 Obtain necessary tools	E-5 Adjust work holding fixtures	
	E-6 Properly place workpiece in machine	E-7 Properly place tool in machine	E-8 Load the control	E-9 Read and interpret the sequence of actions in machine code	E-10 Make first piece and verify	E-11 Edit program: Re-verify as needed

F. Operating Skills	F-1 Perform all in-process measurements	F-2 Adjust for size corrections	F-3 Recognize total wear	F-4 Replace tools	F-5 Return tools for re-sharpening	F-6 Recognize deviations from the normal sequence of operations	F-7 Communicate the Deviations to appropriate person
	F-8 Adjust feeds and speeds for optimum removal - maintain parameters of the workpiece	F-9 Recognize the effects of improper cutting tool Geometry	F-10 Perform routine maintenance functions	F-11 Recognize symptoms of machine tool mis-alignment			
G. Manufacturing Planning Skills	G-1 Develop a workpiece sequence of operations	G-2 Apply principles of feeds and speeds					
H. Programming Skills	H-1 Develop a workpiece sequence of operations	H-2 Edit program					

DACUM Facilitator

Tim Nolan, Cincinnati Technical College

Panel Consultants

Robert Pitzer, Cincinnati Milacron
Fran Coleman, Platt Saco-Lowell
Harold Fowler, Torrington
Rodger Fowler, General Electric Company
Lee M. Swenson, Robert Bosh Company

Sponsored by the S. C. State Board for Technical and Comprehensive Education and Greenville Technical College.

NUMERICAL CONTROL OPERATOR

Reference 3 Suggested Skills: Machinist, Grinder Operator, Drill Press Operator, Lathe Operator, Milling Machine Operator

MACHINIST

600.280-022

Duty A: Bench Work

- Laying out metal surfaces
- Identifying jig buttons
- Using the sine bar
- Using the bevel protractor
- Using steel rules
- Using the micrometer
- Reading a Vernier Scale
- Using dial indicators, center testers and speed indicators
- Using precision gage blocks, tapered ring, plug and snap gages
- Identifying and using hand hacksaws
- Using abrasives and lapping compounds
- Identifying and using files
- Scraping flat and curved bearing surfaces
- Using hammers and screwdrivers for hand bench use
- Identifying and using wrenches
- Using bench vices and clamps
- Identifying and using chipping tools
- Using hand taps, dies and hand reamers
- Identifying power tool safety practices
- Assembling and pitting
- Identifying fasteners
- Using thread, center, fillet and radius gages
- Identifying lubricants and greases
- Performing machine maintenance
- Identifying bench work safety

Duty B: Drilling Machine Work

- Identifying parts and functions of the drilling machine
- Identifying safety practices and precautions when using the drilling machine
- Identifying work-holding devices and setups
- Identifying and using drill bit holding devices

- Computing sharp V-thread formulae
- Identifying acme threads
- Using the acme tap
- Identifying square threads
- Identifying classes of fits of screw threads
- Using threads gages
- Using a thread micrometer
- Measuring threads with the three-wire method
- Cutting threads with an even geared lathe
- Cutting threads on a lathe which is not even geared
- Cutting threads on a quick-change gear lathe
- Identifying multiple lead screw threads
- Cutting left hand threads
- Determining a tap drill size
- Cutting internal threads and tapping
- Identifying principles of taper turning
- Computing tapers
- Measuring short tapers
- Gaging inside and outside tapers
- Tapering by the offset tail stock methods
- Cutting a taper with the compound rest
- Cutting a taper with the taper attachment
- Boring or turning interval tapers
- Identifying coolants and cutting compounds
- Identifying lubricants

Duty D: Turret Lathe Work

- Identifying turret lathes
- Identifying turret lathe safety practices
- Maintaining the turret lathe
- Identifying work holding devices
- Identifying chucking operations on the turret lathe
- Identifying special fixtures and steady rests
- Identifying standard tool holding devices
- Identifying principles of tool grinding
- Selecting cutting speed and feed on the turret lathe

- Cutting internal and external slots and keyways and cutting off in the shaper
- Maintaining and caring for the shaper

Duty G: Planer Work

- Identifying types, sizes, construction, specifications, nomenclature and range of work for planers
- Identifying and using work holding and clamping devices
- Identifying planer cutting tools, grinding them and attaching to machine
- Setting up the planer and calculating speed and feed
- Performing planing operations
- Maintaining and caring for the planer

Duty H: Milling Machine Work

- Identifying types, sizes, construction, specifications, nomenclature and range of work for milling machines
- Identifying milling machine work holding devices and their function
- Identifying, selecting and aligning milling machine attachments
- Selecting and setting up milling machine cutters and holders
- Calculating cutting speeds and feeds for milling machine work
- Performing a plain milling operation
- Performing a face milling operation
- Performing a side milling operation
- Performing a form milling operation
- Performing an angular milling operation
- Performing an end milling operation
- Performing a gang milling operation
- Drilling, boring and reaming with the milling machine

Identifying drill bits
Identifying cutting feeds and speeds
Identifying principles of straight drilling
Identifying and using coolants and cutting compounds
Grinding and care of drills
Identifying and using twist drill gages
Identifying and using drill grinding machines
Identifying machine reamers
Machine reaming
Identifying principles of boring and counterboring
Spot facing
Counter sinking, center drilling, and tapping

Duty C: Engine Lathe Work

Identifying lathe safety
Identifying lathes
Identifying work-holding devices
Identifying cutting tools
Identifying measuring tools
Identifying lathe attachments
Calculating cutting feeds and speeds on the lathe
Determining RPM
Centering stock
Identifying principles of facing
Identifying principles of straight turning and turning to shoulders
Identifying checks
Form turning
Identifying face plate work
Using draw-in collets
Identifying principles of drilling
Identifying machine reamers
Reaming on the engine lathe
Boring on the engine lathe
Identifying and using mandrels
Knurling on the engine lathe
Cutting off on the engine lathe
Identifying thread cutting devices
Identifying the parts of a thread
Identifying American National Thread standards
Computing American National Thread form

Identifying coolants and cutting compounds
Facing on the turret lathe
Using face plates
Forming on the turret lathe
Turning on the turret lathe
Drilling on the turret lathe
Boring on the turret lathe
Reaming on the turret lathe
Taper turning on the turret lathe
Chamfering and grooving on the turret lathe
Threading on the turret lathe

Duty E: Power Saw Work

Identifying power cut-off saws
Identifying power saw safety
Identifying and using work holding devices on the power cut-off saw
Identifying, selecting, mounting and maintaining saw blades
Identifying speeds, feeds and coolants for power cut-off saws
Using the power cut-off saw for straight and angular sawing
Identifying the metal band saw
Identifying coolants and lubricating agents for band saws
Choosing saw blades for the metal band saw
Calculating feeds and speeds for the metal band saw

Duty F: Shaper Work

Identifying types, sizes, construction, specifications, nomenclature and range of work for shapers
Identifying shaper work holding devices and their function
Identifying shaper cutting tools, grinding them and attaching to machine
Setting up the shaper and calculating speed and feed
Adjusting the shaper
Performing a horizontal shaping operation
Performing a vertical shaping operation
Shaping a rectangle or square
Shaping a contour
Performing angular shaping and dovetailing operations

Performing sawing, slitting and cutting off operations with the milling machine
Performing keyseating and T-slot milling operations
Performing indexing operations
Performing circular milling operations
Performing graduating and marking operations
Performing profiling
Maintaining and caring for the milling machine

Duty I: Gears and Gearing

Identifying types of gears and their function
Identifying gear tooth elements and their symbols
Calculating the pitch, diameters, working depth and clearances for machining gears
Milling a spur gear
Milling a gear rack
Milling a stub gear
Milling a bevel gear
Machining a worm gear on the engine lathe

Duty J: Grinder Work

Identifying grinders, grinding wheels and attachments
Using the bench grinder
Using the surface grinder
Using the cylindrical grinder
Using the tool and cutter grinder
Using the centerless grinder
Performing honing and lapping operations

Duty K: Metallurgy

Identifying metal manufacturing processes
Identifying the physical structure of metals
Identifying properties of metals
Identifying methods of heat treatment
Identifying iron manufacturing processes
Identifying processes used to produce steel
Identifying processes used to produce copper, brass, and bronze alloys
Identifying processes used to produce aluminum
Identifying processes for the production of magnesium and titanium

GRINDER OPERATOR
603.280-018

Duty A: Bench Work

Laying out metal surfaces
Identifying jig buttons
Using the sine bar
Using the bevel protractor
Using steel rules
Using the micrometer
Reading a Vernier scale
Using dial indicators, center testers and speed indicators
Using precision gage blocks, tapered ring, plug and snap gages
Identifying and using hand hacksaws
Using abrasives and lapping compounds
Identifying and using files
Scraping flat and curved bearing surfaces
Using hammers and screwdrivers for hand bench use
Identifying and using wrenches
Using bench vices and clamps
Identifying and using chipping tools
Using hand taps, dies and hand reamers
Identifying power tool safety practices
Assembling and pitting
Identifying fasteners
Using thread, center, fillet and radius gages
Identifying lubricants and greases
Performing machine maintenance
Identifying bench work safety

Duty J: Grinder Work

Identifying grinders, grinding wheels and attachments
Using the bench grinder
Using the surface grinder
Using the cylindrical grinder
Using the tool cutter and grinder
Using the centerless grinder
Performing honing and lapping operations

DRILL PRESS OPERATOR

606.682-014

Duty A: Bench Work

- Laying out metal surfaces
- Identifying jig buttons
- Using the sine bar
- Using the bevel protractor
- Using steel rules
- Using the micrometer
- Reading a Vernier scale
- Using dial indicators, center testers and speed indicators
- Using precision gage blocks, tapered ring, plug and snap gages
- Identifying and using hand hacksaws
- Using abrasives and lapping compounds
- Identifying and using files
- Scraping flat and curved bearing surfaces
- Using hammers and screwdrivers for hand bench use
- Identifying and using wrenches
- Using bench vices and clamps
- Identifying and using chipping tools
- Using hand taps, dies and hand reamers
- Identifying power tool safety practices
- Assembling and pitting
- Identifying fasteners
- Using thread, center, fillet and radius gages
- Identifying lubricants and greases
- Performing machine maintenance
- Identifying bench work safety

Duty B: Drilling Machine Work

- Identifying parts and functions of the drilling machine
- Identifying safety practices and precautions when using the drilling machine
- Identifying work-holding devices and set ups
- Identifying and using drill bit holding devices
- Identifying drill bits
- Identifying cutting feeds and speeds
- Identifying principles of straight drilling
- Identifying and using coolants and cutting compounds
- Grinding and care of drills
- Identifying and using twist drill gages
- Identifying and using drill grinding machines
- Identifying machine reamers
- Machine reaming
- Identifying principles of boring and counterboring
- Spot facing
- Counter sinking, center drilling and tapping

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LATHE OPERATOR
604.685-026

Duty A: Bench Work

Laying out metal surfaces
Identifying jig buttons
Using the sine bar
Using the bevel protractor
Using steel rules
Using the micrometer
Reading a Vernier scale
Using dial indicators, center testers and speed indicators
Using precision gage blocks, tapered ring, plug and snap gages
Identifying and using hand hacksaws
Using abrasives and lapping compounds
Identifying and using files
Scraping flat and curved bearing surfaces
Using hammers and screwdrivers for hand bench use
Identifying and using wrenches
Using bench vices and clamps
Identifying and using chipping tools
Using hand taps, dies and hand reamers
Identifying power tool safety practices
Assembling and pitting
Identifying fasteners
Using thread, center, fillet and radius gages
Identifying lubricants and greases
Performing machine maintenance
Identifying bench work safety

Duty C: Engine Lathe Work

Identifying lathe safety
Identifying lathes
Identifying work-holding devices
Identifying cutting tools
Identifying measuring tools
Identifying lathe attachments
Calculating cutting feeds and speeds on the lathe
Determining RPM
Centering stock
Identifying principles of facing
Identifying principles of straight turning and turning to shoulders
Identifying checks
Form turning
Identifying face plate work
Using draw-in collets
Identifying principles of drilling
Identifying machine reamers
Reaming on the engine lathe
Boring on the engine lathe
Identifying and using mandrels
Knurling on the engine lathe
Cutting off on the engine lathe
Identifying thread cutting devices
Identifying the parts of a thread
Identifying American National Thread standards
Computing American National Thread form
Computing sharp V-thread formulas
Identifying acme threads
Using the acme tap
Identifying square threads
Identifying classes of fits of screw threads
Using thread gages
Using a thread micrometer
Measuring threads with the three-wire method
Cutting threads with an even geared lathe
Cutting threads on a lathe which is not even geared
Cutting threads on a quick-change gear lathe
Identifying multiple lead screw threads
Cutting left hand threads
Determining a tap drill size
Cutting interval threads and tapping
Identifying principles of taper turning
Computing tapers
Measuring short tapers
Gaging inside and outside tapers
Tapering by the offset tail stock methods
Cutting a taper with the compound rest
Cutting a taper with the taper attachment
Boring or turning interval tapers
Identifying coolants and cutting compounds
Identifying lubricants

Duty D: Turret Lathe Work

Identifying turret lathes
Identifying turret lathe safety practices
Maintaining the turret lathe
Identifying work holding devices
Identifying chucking operations on the turret lathe
Identifying special fixtures and steady rests
Identifying standard tool holding devices
Identifying principles of tool grinding
Selecting cutting speed and feed on the turret lathe
Identifying coolants and cutting compounds
Facing on the turret lathe
Using face plates
Forming on the turret lathe
Turning on the turret lathe
Drilling on the turret lathe
Boring on the turret lathe
Reaming on the turret lathes
Taper turning on the turet lathe
Chamfering and grooving on the turret lathe
Threading on the turret lathe

MILLING MACHINE OPERATOR
605.685-030

Duty A: Bench Work

Laying out metal surfaces
Identifying jig buttons
Using the sine bar
Using the bevel protractor
Using steel rules
Using the micrometer
Reading a Vernier scale
Using dial indicators, center testers and speed indicators
Using precision gage blocks, tapered ring, plug and snap gages
Identifying and using hand hacksaws
Using abrasives and lapping compounds
Identifying and using files
Scraping flat and curved bearing surfaces
Using hammers and screwdrivers for hand bench use
Identifying and using wrenches
Using bench vices and clamps
Identifying and using chipping tools
Using hand taps, dies and hand reamers
Identifying power tool safety practices
Assembling and pitting
Identifying fasteners
Using thread, center, fillet and radius gages
Identifying lubricants and greases
Performing machine maintenance
Identifying bench work safety

Duty H: Milling Machine Work

Identifying types, sizes, construction, specifications, nomenclature and range of work for milling machines
Identifying milling machine work holding devices and their function

Identifying, selecting and aligning milling machine attachments
Selecting and setting up milling machine cutters and holders
Calculating cutting speeds and feeds for milling machine work
Performing a plain milling operation
Performing a face milling operation
Performing a side milling operation
Performing a form milling operation
Performing an angular milling operation
Performing an end milling operation
Performing a gang milling operation
Drilling, boring and reaming with the milling machine
Performing sawing, slitting and cutting off operations with the milling machine
Performing keyseating and T-slot milling operations
Performing indexing operations
Performing circular milling operations
Performing graduating and marking operations
Performing profiling
Maintaining and caring for the milling machine

Duty I: Gears and Gearing

Identifying types of gears and their function
Identifying gear tooth elements and their symbols
Calculating the pitch, diameters, working depth and clearances for machining gears
Milling a spur gear
Milling a gear rack
Milling a stub gear
Milling a bevel gear
Machining a worm gear on the engine lathe

Reference 4 Survey of Secondary Level Lab Facilities

SURVEY RESULTS
SECONDARY MACHINE SHOP LAB FACILITIES
(for articulation purposes)

A survey of the secondary Machine Shop program yielded the following information concerning the major types of machines, equipment, and measuring tools that are available for instruction.

For articulation purposes, the survey results indicates similar machine shop training equipment at the three secondary career centers.

The survey does not reflect the age or condition of the measuring instruments or machines and, in some cases, the training equipment may be deadlined or in need of repairs.

Greenville Technical College's Machine Technology program was omitted from the survey since the post-secondary program features equipment similar or equivalent to that found in local industry, including NC/CNC technology. Equipment in the TEC Machine Technology program is updated regularly through industrial donations, grants, and other activities that have allowed the program to become a resource center for machine technology training in the State and Nation.

	CAREER CENTER		
Gages and Measuring Equipment (larger)	Donaldson	Enoree	Foothills
Go-No Go Ring Gages			
Dial Bore Gage			
Dial Depth Gage			
Cylindrical Square			
Optical Flat			
Gage Blocks	X	X	X
Comparator	X		
Optical Comparator	X		
Bench Center			
Sine Bar	X	X	
Snap Gages			
Vernier Height Gage	X	X	X
Height Micrometer			

Machine Shop Equipment

Pedestal Grinder	X	X	X
Drill Press	X	X	X
Horizontal Band Saw	X	X	X
Vertical Band Saw	X	X	X
Power Hacksaw			X
Engine Lathe	X	X	
Milling Machine	X	X	X
Turret Lathe	X	X	X
Shaper	X	X	
Tool & Cutter Grinder	X	X	X
Surface Grinder	X	X	X
Cylindrical Grinder			X
Welder	X	X	
Heat Treatment Equipment	X	X	
Hydraulic Press	X	X	
NC/CNC Trainer: Emco Compact 5 CNC Lathe	X	X	X

This survey results page is accompanied by page of definitions of gaging tools.

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DEFINITIONS

GAGING TOOLS

Dial Bore Gage	Used to check the bore of parts to .0001 accuracy, preset with a ring gage.
Dial Depth Gage	Used to check depth of holes, slots, and grooves, and recesses.
Cylindrical Square	Used as meter against which other squares may be checked.
Cylindrical Plug Gage	Has "go" and "no-go" ends, used to check bore of parts to .0001 accuracy.
Optical Flat	Uses light waves to measure flatness, parallelism, and size.
Gage Blocks	Used to check measurements, set fixed gages, calibrate measuring tools, set comparators, inspect and perform other set-ups (.000001).
Comparator	Used to inspect size of parts from a flat surface.
Bench Center	Used to check concentricity of machined parts.
Sine Bar	Used to set up or inspect angular surfaces of 45 degrees or less.
Snap Gages	Used to check parts within certain limits of a predetermined, fixed dimension.
Vernier Height Gage	Used as a vertical capiper to scribe lines within .0001 inch in layout, to measure depth, and to gage a machined surface.
Height Micrometer	Used to set other measuring tools for inspection by comparison, accurate to .00001 inch.
Surface Plate	A reference plane for precision measurement; when used with other gages, the surface plate becomes a gage itself.

NOTE: Other measuring instruments omitted since they are standard items in a machine shop or are classified as smaller (in size or price) gaging or measuring tools.

Reference 5 Recommended Secondary Level T & I Equipment

TRADE AND INDUSTRIAL EDUCATION EQUIPMENT LIST

MACHINE SHOP COURSE

REVISION DATE: May 16, 1980

In establishing a new program, school districts will be funded for only basic instructional equipment indicated on this list, if and when funds become available. Where a particular piece of equipment is not indicated on this list but is utilized by local industry and is requested by a school district, a statement explaining the need should be attached to the list of requested equipment by the appropriate school administrator.

Equipment on the state list has an item number. In order to accelerate processing, the item number on your requested list should correspond with the number on the state list. (NOTE: If item 5 on the state list is not requested, omit that item number (5) and drop down to item number 6, if requested.)

THE COMMITTEE OF INSTRUCTORS THAT COMPOSED THIS LIST HAS INDICATED PARTICULAR MANUFACTURERS OR SOURCES OF EQUIPMENT, HOWEVER, ANY EQUIVALENT EQUIPMENT MAY BE SUBSTITUTED BY THE LOCAL SCHOOL DISTRICT.

ITEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
1.	1	Acme screw thread gauge	Rutland	RTG71	9.20	9.20
2.	2	12" Adjustable wrench	W. W. Grainger		10.62	21.24
3.	6	8" Adjustable wrench	W. W. Grainger		6.98	41.88
4.	1	Assortment of end mills			575.00	575.00
5.	1	Assortment of lathe dogs			230.00	230.00
6.	6	Ball been hammer 16 oz.	W. W. Grainger		7.84	47.04
7.	1	Bar rack			461.67	461.67
8.	1	Bench Grinder 6"	Baldor	612	146.84	146.84
9.	4	Bench vise heavy duty 5"	Wilton or Craftsman		160.84	643.36
0.	1	Bevel Protractor	Starrett	359B	96.77	96.77
1.	1	Boring head	ENCO		361.00	361.00

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MACHINE SHOP COURSE PAGE 2 OF 9 PAGES

ITEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
12.	1	Carbide grinder 6"	Rockwell	25-502 with 23-805 peds	441.20	441.20
13.	1	Center drill set	Union	21½	18.01	18.01
14.	1	Center finder (Wiggler)	Starrett	828	17.20	17.20
15.	6	Center gauges	General		5.17	31.02
16.	1	Center punch set (6)	Starrett	117	14.95	14.95
17.	1	Chair			119.60	119.60
18.	1	Clamping kit (T bolts, studs, step blocks & clamps)			168.00	168.00
19.	12	#3 Combination center drill, counter sink			3.10	37.20
20.	1	Combination wrench set 3/8 to 13/16	S. K. Wayne		55.06	55.06
21.	6	Combination square sets			52.32	313.92
22.	10	Depth micrometers o" to 6"	Starrett	440-6L	71.00	710.00
23.	1	Dial caliper (metric)	Graves-Humphries	478277	56.92	56.92
24.	2	Dial indicators	Starrett	711GCS	66.51	133.02

MACHINE SHOP COURSE PAGE 3 OF 9 PAGES

ITEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
25.	6	4" Divider			8,05	48,30
26.	1	Dividing Head	Cincinatti		1,955,00	1,955,00
27.	1	Dividing Head 11"	Economy		977,50	977,50
28.	3	Drill chucks ½" cap. with #2 or #3 Morse Taper (Expendable Item)	Jacobs		45,90	737,70
29.	1	Drill grinder, 1/8 to 1-1/4	Lisle	91000	356,50	356,50
30.	1	Drill point gauge	Starrett	22C	13,51	13,51
31.	2	15" Drill press, variable speed	Rockwell	15-467 with 49-711 motor	822,25	1,644,50
32.	2	Drill press vise	Neal		94,87	189,74
33.	2	Drill sets 1/16 to 1/2 by 64ths			58,85	117,70
34.	2	Drive pin punch sets	Starrett	565	14,66	29,32
35.	1	Edge finder	"	879	12,80	12,80
36.	2	Engine lathe 13" (6ft. bed)	Clausing		11,600,00	23,200.00
37.	1	7" Grinder pedestal	Baldor	SP-7PIMD	451.06	451.06
38.	1	12" Grinder pedestal	"	SP-1221MD	1,092.66	1,092.66

MACHINE SHOP COURSE PAGE 4 OF 9 PAGES

TEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
39.	6	Hack saws			8,05	48,30
40.	1	Hardness tester	king	134	1,207,50	1,207,50
41.	1	Heat treat furnace (complete)	Crest		2,127,50	2,127,50
42.	6	Hermaphrodite caliper 6"	Starrett	563	11,04	66,24
43.	1 Set	Hole gauges	"	S-830F	44.70	44.70
44.	1	Horizontal metal cut off sawq	Wells	#8	2,064,25	2,064.25
45.	2	Horizontal milling machine	Powermatic	333	14,462,40	28,924,80
46.	1	Horizontal milling machine (Universal)		LUER	16,373,55	16,373.55
47.	6	4" Inside Caliper			8.05	48.30
48.	1	Inside micrometer	Starrett	124B	70.25	70.25
49.	1	Inside micrometer 1½" to 12"	"	823B	77.10	77.10
50.	1	Keyseat rule	Starrett	237	13.80	13.80
51.	8	15" x 54" LeBlond Geared Head Engine Lathe, servo-shift, 12 spindle speeds with hardened and ground replaceable bedways, face plate, inch/metric switchable dual English/metric dials open type tool post, 7½ H.P. motor with J.I.C. electrics.	LeBlond		11,850.00	94,800.00

MACHINE SHOP COURSE PAGE 5 OF 9 PAGES

TEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
52.	1	Letter drill set A to Z			62.90	62.90
53.	1	Level 14" cast iron	Starrett	133B	87.00	87.00
54.	10	0-1 Micrometers (Vernier)	Starrett		44.26	442.60
55.	2	2" Micrometers	"	436RL-2"	45.60	91.20
56.	1	3" Micrometer	Starrett	436RL-3"	48.40	48.40
57.	1	4" Micrometer	"	436RL -4"	53.50	53.50
58.	1	5" Micrometer	"	436RL-5"	57.14	57.14
59.	1	6" Micrometer	"	436RL-6"	59.00	59.00
60.	1	Micrometer depth gauge w/ratchet stop and lock nut (metric)	Graves-Humphries	478412	44.70	44.70
61.	3	Milling machine vises 4½" plain 4½" swivel, 4½" universal			345.00	1,035.00
62.	1 Set	Minute man broaches	Dumont	#10	178.00	178.00
63.	1	Number (wire gauge) drills 1 to 60	Craftsman		55.52	55.52
64.	6	4" Outside caliper	Mitutoyo or equiv		8.05	48.30
65.	1	Outside micrometer w/ratchet stop and lock nut (metric)	Graves-Humphries	478372	37.10	37.10

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EM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
66.	1	Oxy-Ace Welding Outfit			271.00	271.00
67.	2 Sets	Parallels	Starrett	S-384-J	98.61	197.22
68.	6	Pocket scribers	"	70	3.12	18.72
69.	1	Press arbor 2 ton	G.H.		341.00	341.00
70.	1	Protractor	Rutland		8.05	8.05
71.	2	Punch and chisel set			72.24	144.48
72.	1	Radial drill	Rockwell	15-126	2,700.00	2,700.00
73.	1	Radius gauge set	Rutland		33.92	33.92
74.	1 Set	Reamers ¼" to 1" (by 16th)	Cleveland	27A	323.43	323.43
75.	2	Revolving head knurlers			68.40	136.80
76.	40	Safety glasses			7.40	296.00
77.	1	Screw thread mike	Starrett	575A-P	113.27	113.27
78.	1	Set of gauge blocks	Rutland		470.00	470.00
79.	1	Set of gear cutters #8-14-20 DP, also other pitches	National		690.00	690.00

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MACHINE SHOP COURSE PAGE 7 OF 9 PAGES

EM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
80.	1	Set of metric gears for 10K South Bend Lathe	South Bend		430.10	430.10
81.	2	Sets of screw drivers			21.08	42.16
82.	1	Set screw extractors (E-Z outs)			9.80	9.80
83.	10	Sets of V-Blocks	B & S	749A	27.00	270.00
84.	1	Shapers	South Bend	CS100	2,309.20	2,309.20
85.	1	Socket set	SK Wayne		66.70	66.70
86.	2	Soft faced hammers 16oz.			9.63	19.26
87.	1	Steel file cabinet		2604	181.70	181.70
88.	1	Steel foremans desk		7535	192.05	192.05
89.	30	Steel rules 6"	General		3.62	108.60
90.	1	Steel stamps 1/8" letters & numbers			36.00	36.00
91.	2	10' Steel tapes	Craftsman		5.52	11.04
92.	2	Surface gauges, Rutland 12"		621B	42.60	85.20
93.	1	6 x 18 Surface grinder (Hyd. table)	Harig	4350	7,998.25	7,998.25

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MACHINE SHOP COURSE PAGE 8 OF 9 PAGES

TEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
94.	1	Surface place, 12" x 18" x 3"	Starrett		248,40	248,40
95.	1	Swivel machine vise	Palmgreen	610	165,00	165,00
96.	1	Tap and die set ¼ to 1" N.C. & N. P.	Greenfield		316.25	316.25
97.	1	Tap and die set 4-40 to 12-24			44.60	44.60
98.	1	Taper shank twist drill set of 32 33/64 to 1 1/64	National		460.00	460.00
99.	1	Telescope gauges	Starrett	S-579H	68.50	68.50
100.	3	T Handle tap wrench small			6.83	20.49
101.	3	T Handle tap wrench large			10.05	30.15
102.	1	Tool and cutter grinder	Rockwell	25-502 with 23-805 pads	529.44	529.44
103.	1	Toolmaker buttons (set of 4)	Starrett	494	16.56	16.56
104.	1	Toolmakers parallel clamp	"	161B	17.10	17.10
105.	1	Toolmakers parallel clamp	"	161D	25.72	25.72
106.	1	Toolmakers parallel clamp	"	161E	29.60	29.60
107.	1	Universal rotary table	12" ENCO	73104	747.15	747.15

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MACHINE SHOP COURSE PAGE 9 OF 9 PAGES

TEM NO.	QUANTITY	ITEM & SIZE	MANUFACTURER OR SOURCE	MODEL	UNIT COST	TOTAL COST
108.	2	6" Vernier Caliper	Starrett or Craftsman		43.12	86.24
109.	1	Vernier Height gauge	Rutland	RHL2	241.00	241.00
110.	1	Vertical band saw (with welder)	Rockwell or Powermatic	28-345 with 52-455 & 49	4,255.00	4,255.00
111.	1	Vertical milling machine	Rockwell	21-100 with 49-68- motor	4,260.00	4,260.00
112.	1	Welding booth 2 stations with curtain	Marquette	15-951	413.57	413.57
113.	1	Welder, AC-DC	Lincoln	230 amp	310.00	310.00
114.	2	Welders protective gear kits			75.90	151.80
115.	6	Work benches 2/steel top	Lyons		167.95	1,007.70
					TOTAL........	$214,691.26
					TAX..........	8,587.65
					GRAND TOTAL..	$223,278.91

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SAMPLE
OUTCOME-REFERENCED TESTS

This articulated, performance-based instruction guide is designed to answer three critical questions necessary for quality instruction.

First, what should be taught?

> The objectives of the articulated, performance-based vocational education program are based on extensive task analysis and validation.
>
> The task objectives represent what employers in business and industry say is important for entry level job success.

Second, how should it be taught?

> It should be taught using the latest "state-of-the-art" instructional technology incorporated into each unit.
>
> Students are taught the knowledges, skills, and attitudes needed for successful and productive employment.

Third, how should students be evaluated?

> Students are evaluated using a validated, competency-based approach to determine student proficiency in vocational knowledges and skills.
>
> The minimum standards are those required for successful entry into the next higher level of training or for successful employment.

The sample tests in this guide are included to illustrate how a student's competency in vocational skills and knowledges may be measured with validity and reliability. In addition, the test samples should promote standardization in the evaluation of vocational students in similar programs.

Test items have been constructed solely from the objectives of the vocational program. The statement of the objectives indicate the level of knowledge or skill to be tested. Task force committee participants have attempted to develop tests that agree with objectives in the behavior requested, the given conditions, and the desired standards of performance.

NOTE: Unless a test is marked "Revised" or "R," the test should be considered a field trial edition currently under evaluation.

PROFICIENCY RATING
0 / 1 / 2 / 3 / 4

COMPETENCY RATING
0 / 1 / 2 / 3 / 4

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

The purpose of the proficiency rating is to communicate to the student, other instructors or potential employers the abilities that a student has demonstrated to the instructor in vocational training.

Circle the student's proficiency, competency, or performance rating as skill is demonstrated.

If instruction is not aimed at task proficiency/competency/performance, or if only an orientation or introduction to the task was provided DO NOT mark a proficiency level or mark 0.

Levels 1-4 indicate that performance was demonstrated and the demonstrated skill level was as follows:

LEVEL 0	No skill level demonstrated or proficiency not obtained
LEVEL 1	Skill level is not that generally expected for entry level employment
LEVEL 2	Skill level probably is that generally expected for entry level employment, but close on-the-job supervision probably will be needed for a while longer
LEVEL 3	Skill level is that generally expected for entry level employment
LEVEL 4	Skill level is that equal to a worker with some on-the-job experience

ADD THE FOLLOWING FRACTIONS:

1.
$$\begin{array}{rl} & \frac{7}{16} \\ + & \\ & \frac{5}{32} \\ \hline \end{array}$$

2.
$$\begin{array}{rl} & \frac{15}{64} \\ + & \\ & \frac{1}{8} \\ \hline \end{array}$$

3.
$$\begin{array}{rl} & \frac{3}{8} \\ + & \\ & \frac{1}{4} \\ & \frac{5}{16} \\ \hline \end{array}$$

4.
$$\begin{array}{rl} & \frac{1}{2} \\ + & \\ & \frac{9}{16} \\ & \frac{7}{64} \\ \hline \end{array}$$

5.
$$\begin{array}{rl} & \frac{3}{8} \\ + & \\ & \frac{5}{16} \\ & \frac{1}{4} \\ \hline \end{array}$$

6.
$$\begin{array}{rl} & \frac{15}{16} \\ + & \\ & \frac{7}{8} \\ & \frac{19}{32} \\ \hline \end{array}$$

7.
$$\begin{array}{rl} & \frac{1}{2} \\ + & \\ & \frac{1}{4} \\ & \frac{1}{8} \\ & \frac{1}{16} \\ \hline \end{array}$$

8.
$$\begin{array}{rl} & \frac{21}{32} \\ + & \\ & \frac{5}{8} \\ & \frac{9}{64} \\ \hline \end{array}$$

9.
$$\begin{array}{rl} & \frac{3}{8} \\ + & \\ & \frac{17}{64} \\ & \frac{5}{32} \\ \hline \end{array}$$

10.
$$\begin{array}{rl} & \frac{1}{2} \\ + & \\ & \frac{3}{4} \\ & \frac{9}{16} \\ & \frac{1}{8} \\ & \frac{9}{32} \\ & \frac{5}{64} \\ \hline \end{array}$$

SUBTRACT AND REDUCE THE FOLLOWING TO LOWEST TERMS.

1. $\begin{array}{r} \frac{9}{16} \\ - \\ \frac{3}{16} \\ \hline \end{array}$

2. $\begin{array}{r} \frac{9}{16} \\ - \\ \frac{1}{16} \\ \hline \end{array}$

3. $\begin{array}{r} \frac{15}{32} \\ - \\ \frac{5}{32} \\ \hline \end{array}$

4. $\begin{array}{r} \frac{27}{64} \\ - \\ \frac{9}{64} \\ \hline \end{array}$

5. $\begin{array}{r} \frac{7}{8} \\ - \\ \frac{3}{4} \\ \hline \end{array}$

6. $\begin{array}{r} \frac{3}{4} \\ - \\ \frac{1}{8} \\ \hline \end{array}$

7. $\begin{array}{r} \frac{7}{8} \\ - \\ \frac{1}{4} \\ \hline \end{array}$

8. $\begin{array}{r} \frac{3}{4} \\ - \\ \frac{3}{16} \\ \hline \end{array}$

9. $\begin{array}{r} \frac{9}{16} \\ - \\ \frac{3}{32} \\ \hline \end{array}$

10. $\begin{array}{r} \frac{9}{64} \\ - \\ \frac{1}{8} \\ \hline \end{array}$

DIVIDE THE FOLLOWING FRACTIONS:

1. $\dfrac{\frac{1}{2}}{\frac{1}{4}} =$

2. $\dfrac{\frac{1}{8}}{\frac{1}{16}} =$

3. $\dfrac{\frac{1}{4}}{\frac{1}{32}} =$

4. $\dfrac{\frac{1}{4}}{\frac{5}{8}} =$

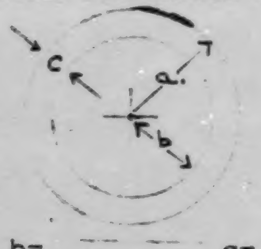
5. $\dfrac{\frac{3}{4}}{\frac{3}{8}} =$

MODULE 1.0 - UNIT 1.0F BASIC MATH: TOLERANCE TEST

ACCURATELY IDENTIFY THE UPPER AND LOWER LIMITS OF THE FOLLOWING DIMENSIONS:

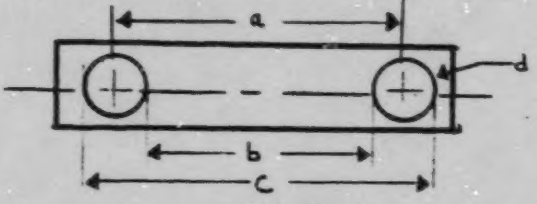
DIMENSIONS	UPPER LIMIT	LOWER LIMIT
1. $1.500^{+.002}_{-.000}$		
2. $2.812 \pm .005$		
3. $1.375^{+.000}_{-.001}$		
4. $2.050 \pm .0005$		
5. $7.701^{+.000}_{-.100}$		
6. $.937 \pm .010$		
7. $1.007 \pm .002$		
8. $.070 \pm .001$		
9. $1.000^{+.002}_{-.003}$		
10. $0.707^{+.005}_{-.001}$		
11. $9.709 \pm .001$		
12. $.709^{+.002}_{-.001}$		
13. $2.500 \pm .006$		
14. $.001^{+.0025}_{-.0000}$		
15. $8.750^{+.0005}_{-.0003}$		
16. $.075 \pm .0003$		
17. $.0625^{+.002}_{-.001}$		
18. $1.025 \pm .003$		
19. $9.999^{+.010}_{-.001}$		
20. $.060^{+.0020}_{-.0010}$		

COMPUTE THE MISSING DIMENSION IN PROBLEMS 1-10.

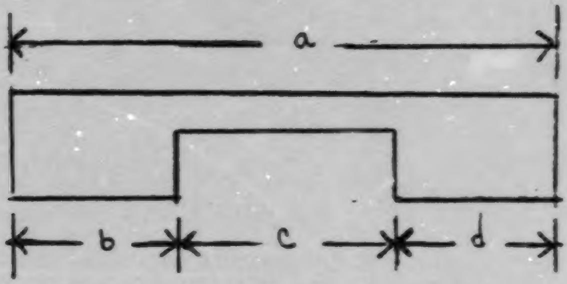


				ANSWER
1.	a=.1875	b=	c=.0156	b=
2.	a=.2187	b=.1719	c=	c=
3.	a=	b=.1875	c=.0625	a=
4.	a=.250	b=.1719	c=	c=
5.	a=.3437	b=	c=.1094	b=
6.	a=	b=.3125	c=.1406	a=
7.	a=.75	b=	c=.2656	b=
8.	a=	b=.6187	c=.2171	a=
9.	a= 3/4	b= 19/32	c=	c=
10.	a= 61/64	b=	c= 7/64	b=

COMPUTE THE MISSING DIMENSIONS IN PROBLEMS 11-20.



					ANSWER	
11.	a= 1 1/8	b=	c=	d= 9/32	b=	c=
12.	a= 1 1/2	b=	c=	d= 5/16	b=	c=
13.	a= 2 3/16	b=	c=	d= 1/8	b=	c=
14.	a= 1 15/16	b=	c=	d= 1/4	b=	c=
15.	a= 63/64	b=	c=	d= 3/64	b=	c=
16.	a= 4 5/8	b=	c=	d= 1/2	b=	c=
17.	a=	b= 1 1/2	c=	d= 1/8	a=	c=
18.	a=	b= 63/64	c=	d= 1/4	a=	c=
19.	a= 1 3/4	b= 1 9/16	c=	d=	c=	d=
20.	a= 2 63/64	b= 1 31/64	c=	d=	c=	d=



FIND THE DIMENSION D, IN INCHES, IN PROBLEMS 1-10.

1. a= 5 1/4 b= 1 1/16 c= 2 3/4 d=__________

2. a= 5 7/16 b= 15/16 c= 4 1/64 d=__________

3. a= 3 59/64 b= 1 1/2 c- 1 3/4 d=__________

4. a= 2 7/16 b= 5/8 c= 29/32 d=__________

5. a= 7 1/8 b= 2 1/16 c= 3 3/16 d=__________

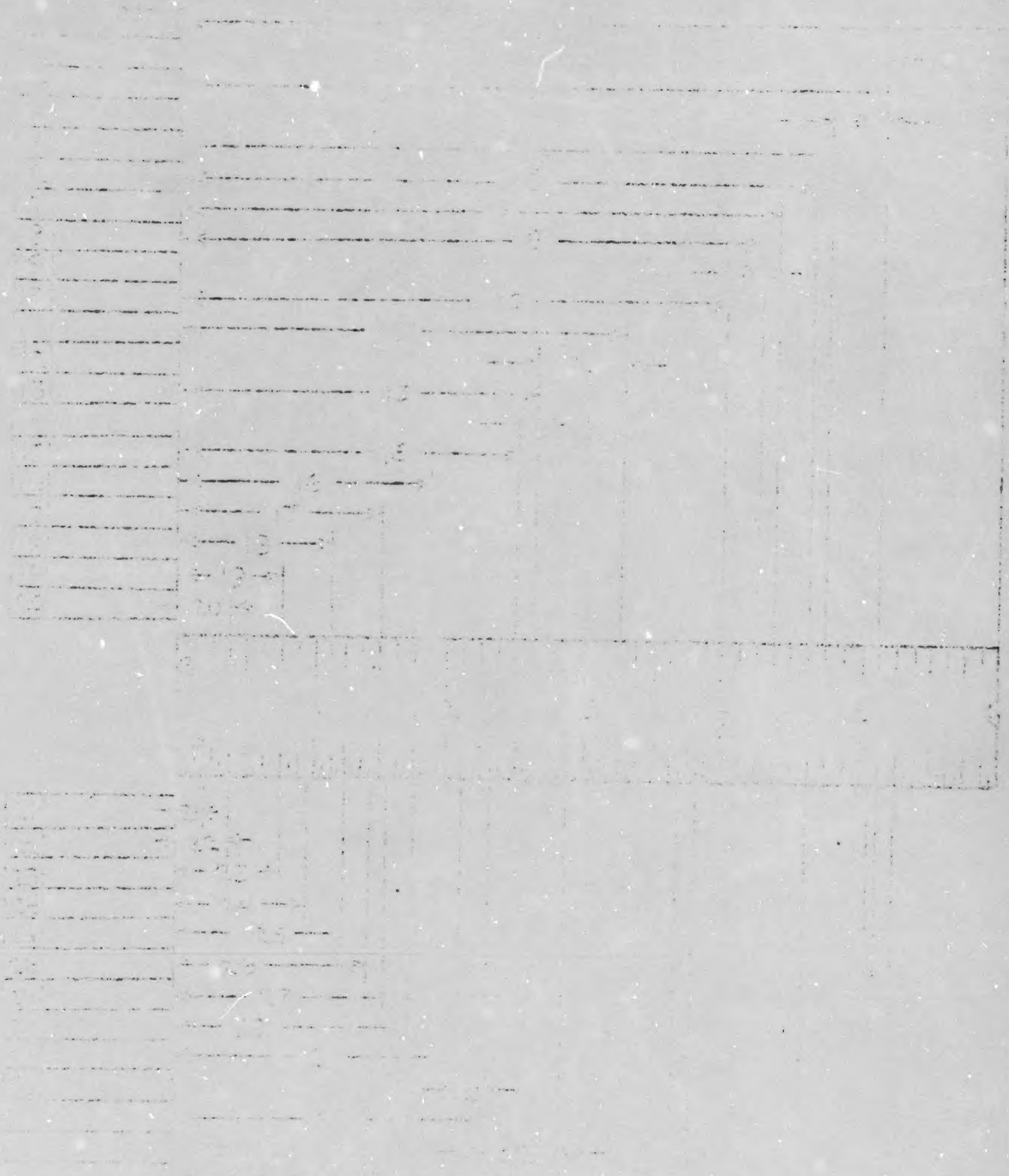
6. a= 7 5/8 b= 2 7/64 c= 2 17/32 d=__________

7. a= 8 7/64 b= 3 5/32 c= 3 33/64 d=__________

8. a= 6 7/16 b= 1 57/64 c= 2 1/8 d=__________

9. a= 5 3/16 b= 1 3/16 c= 2 9/32 d=__________

10. a= 7 23/32 b= 1 3/4 c= 2 1/8 d=__________



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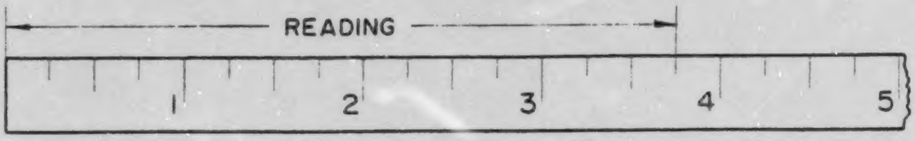
DETERMINE THE READINGS INDICATED ON EACH SHOP SCALE AND PRINT THE ANSWERS IN THE SPACES PROVIDED.

1.


READING
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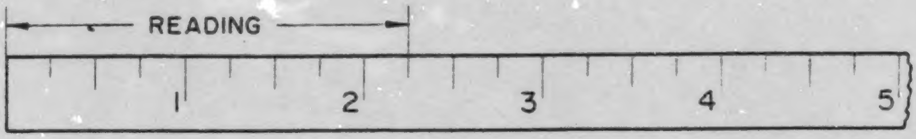
1. ________

2.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2. ________

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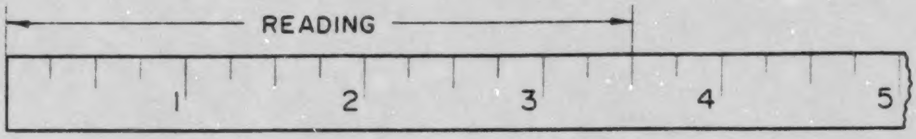
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3. ________

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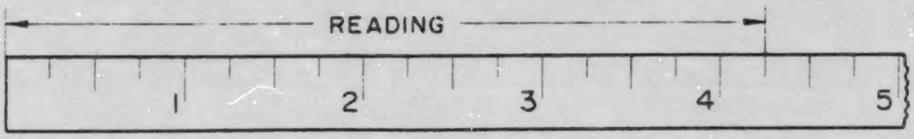
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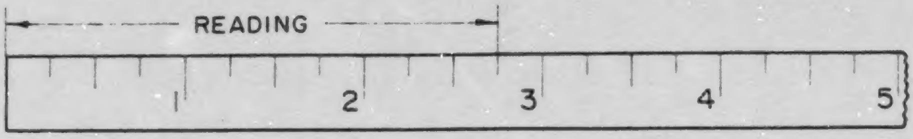
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5. ________

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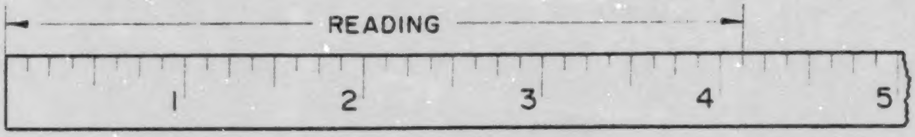
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6. ________

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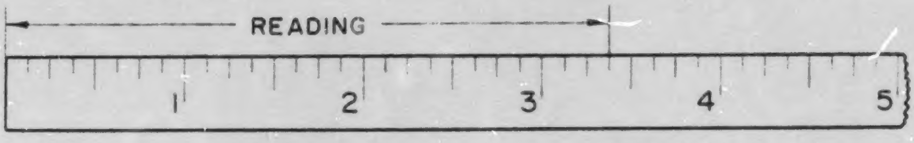
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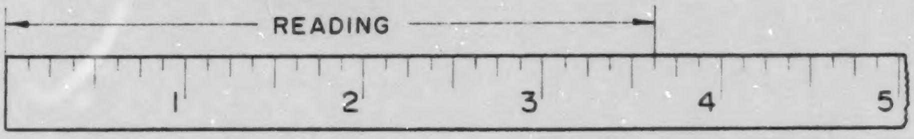
7. ________

8.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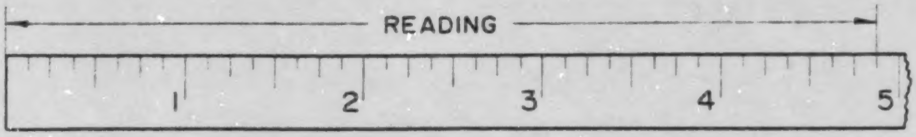
8. ________

9.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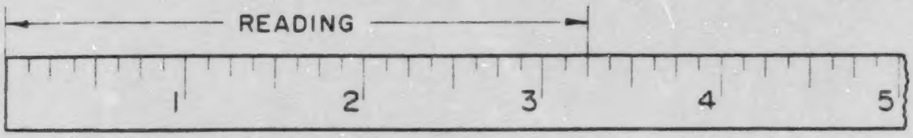
9. ________

10.

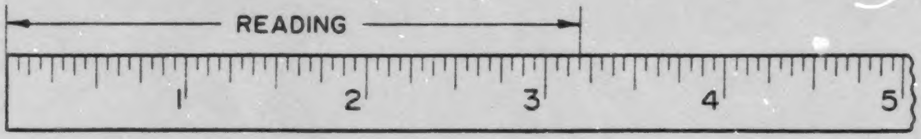

READING
1
2
3
4
5

10. ________

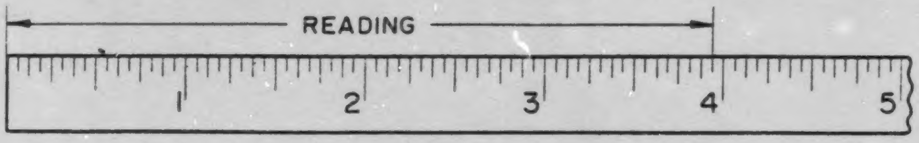
SCALE READINGS #1

BEST COPY AVAILABLE

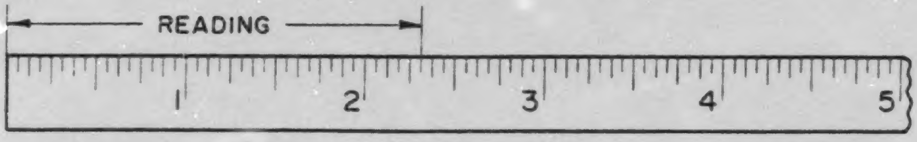
DETERMINE THE READINGS INDICATED ON EACH SHOP SCALE AND PRINT THE ANSWERS IN THE SPACES PROVIDED.

1.

READING
1
2
3
4
5

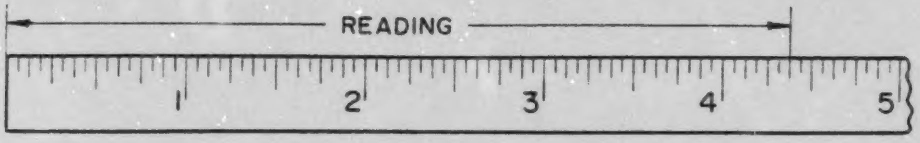
1. ____

2.

READING
1
2
3
4
5

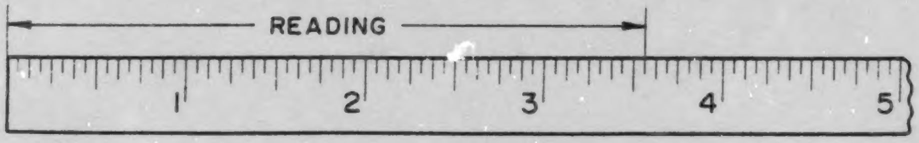
2. ____

3.

READING
1
2
3
4
5

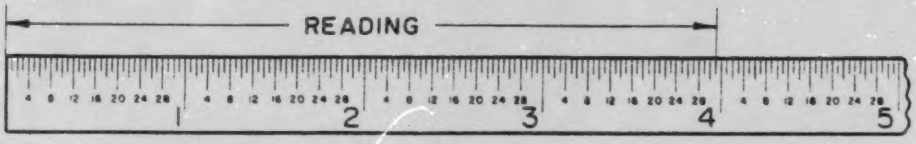
3. ____

4.

READING
1
2
3
4
5

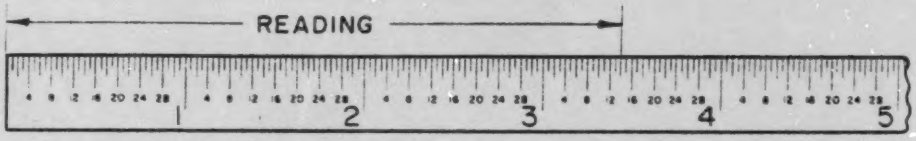
4. ____

5.

READING
1
2
3
4
5

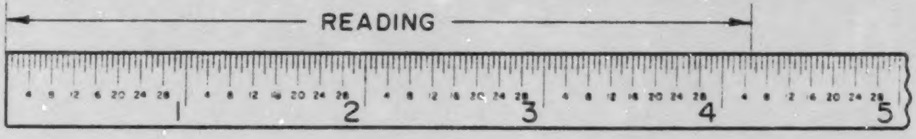
5. ____

6.

READING
4 8 12 16 20 24 28
1
4 8 12 16 20 24 28
2
4 8 12 16 20 24 28
3
4 8 12 16 20 24 28
4
4 8 12 16 20 24 28
5

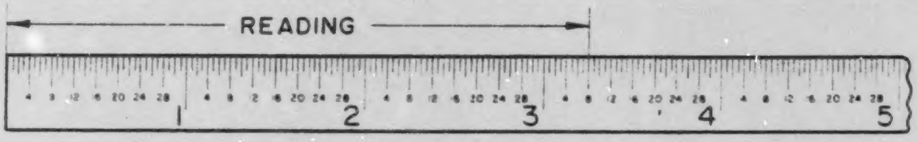
6. ____

7.

READING
4 8 12 16 20 24 28
1
4 8 12 16 20 24 28
2
4 8 12 16 20 24 28
3
4 8 12 16 20 24 28
4
4 8 12 16 20 24 28
5

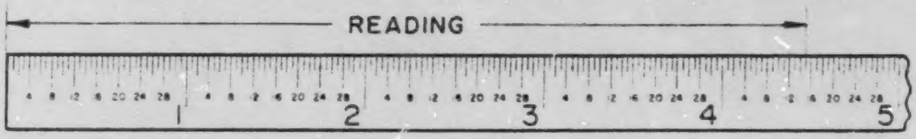
7. ____

8.

READING
4 8 12 16 20 24 28
1
4 8 12 16 20 24 28
2
4 8 12 16 20 24 28
3
4 8 12 16 20 24 28
4
4 8 12 16 20 24 28
5

8. ____

9.

READING
4 8 12 16 20 24 28
1
4 8 12 16 20 24 28
2
4 8 12 16 20 24 28
3
4 8 12 16 20 24 28
4
4 8 12 16 20 24 28
5

9. ____

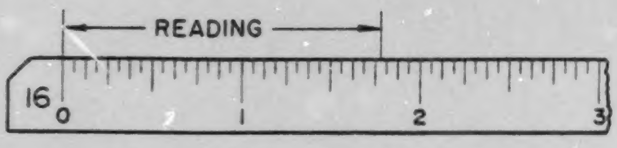
10.

READING
4 8 12 16 20 24 28
1
4 8 12 16 20 24 28
2
4 8 12 16 20 24 28
3
4 8 12 16 20 24 28
4
4 8 12 16 20 24 28
5

10. ____

#2

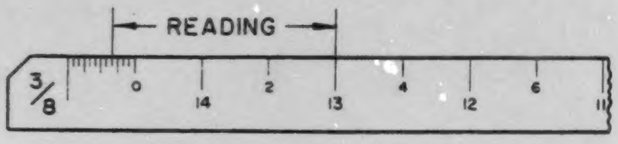
DETERMINE THE READINGS INDICATED ON THE ARCHITECT'S SCALES AND PRINT THE ANSWERS IN THE SPACES PROVIDED.

1.


READING
16
0
1
2
3

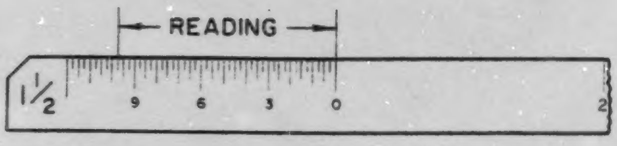
1. ________

2.


READING
3/8
0
14
2
13
4
12
6
11

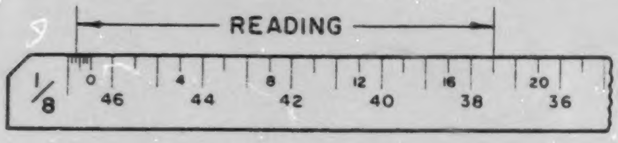
2. ________

3.


READING
1 1/2
9
6
3
0
2

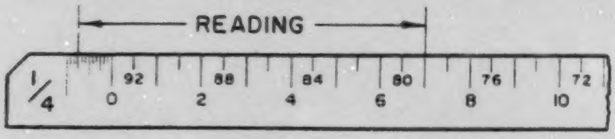
3. ________

4.


READING
1/8
0
46
4
44
8
42
12
40
16
38
20
36

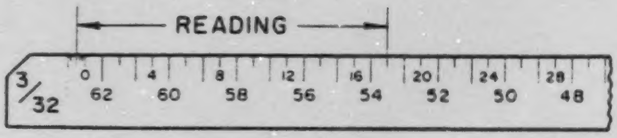
4. ________

5.


READING
1/4
92
0
88
2
84
4
80
6
76
8
72
10

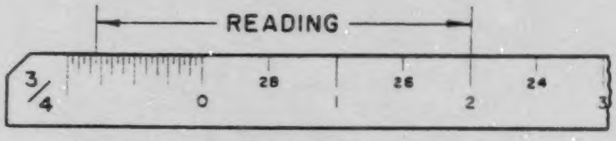
5. ________

6.


READING
3/32
0
62
4
60
8
58
12
56
16
54
20
52
24
50
28
48

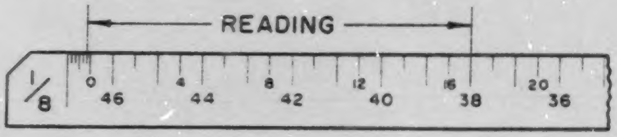
6. ________

7.


READING
3/4
0
28
1
26
2
24
3

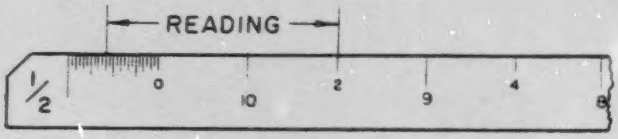
7. ________

8.


READING
1/8
0
46
4
44
8
42
12
40
16
38
20
36

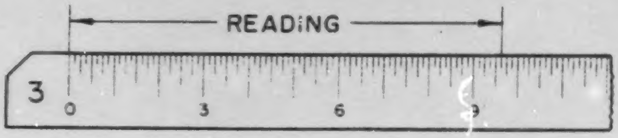
8. ________

9.


READING
1/2
0
10
2
9
4
8

9. ________

10.


READING
3
0
3
6
9

10. ________

#3

641

MULTIPLE CHOICE:

1. An/a ______________ drawing shows how parts are put together.

   a. perspective
   b. detail
   c. assembly
   d. isometric
   e. oblique

2. An assembly drawing has _____________or more objects.

   a. one
   b. two
   c. three
   d. four
   e. five

3. Part identification on an assembly drawing is by ________.

   a. triangles
   b. numbers
   c. arrows
   d. lines
   e. views

4. A detail drawing is a drawing of a/an ________piece.

   a. single
   b. double
   c. sectioned
   d. oblique
   e. specified

5. An assembly drawing is a drawing of _________ or more details.

   a. two
   b. one
   c. three
   d. four
   e. five

6. An assembly drawing is a completely ___________construciton.

   a. removed
   b. separate
   c. assembled
   d. detailed

7. The detail drawing is a drawing of a _________piece.

   a. medium
   b. small
   c. double
   d. single
   e. large

8. An assembly drawing shows how parts are ________together.

   a. cut
   b. styled
   c. put
   d. curved
   e. detailed

9. Balloons are identifying symbols used on _________ drawings.

   a. perspective
   b. detail
   c. assembly
   d. isometric
   e. framed

10. The true shape of an object with slanted surfaces can only be represented by a/an _____________view.

   a. cavalier
   b. perspective
   c. auxiliary
   d. isometric
   e. oblique

11. The usual views of an object do not show the true shapes of _________________surfaces.

   a. staight
   b. slanting
   c. isometric
   d. square
   e. triangular

12. True sizes and shapes of slanted surfaces are obtained by projecting directly from the _________.

   a. right
   b. section
   c. slant
   d. finish

13. A draftsman may use a/an _________drawing as a means of presenting his ideas more simply.

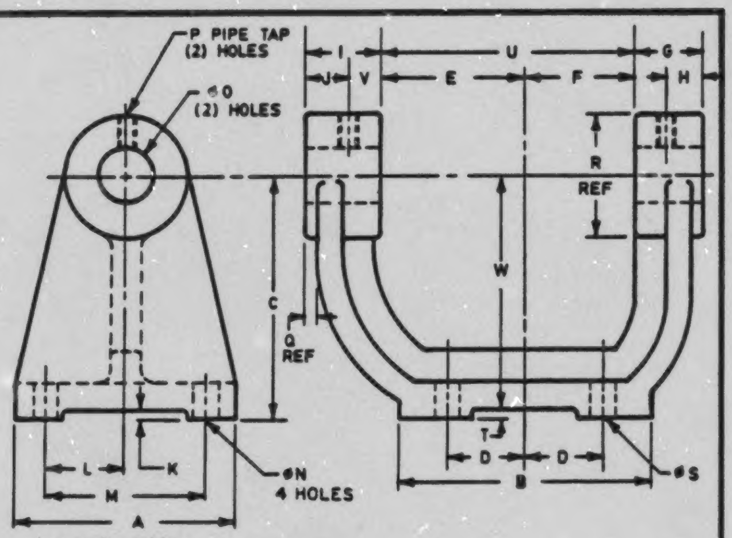
   a. orthogrphic
   b. pictorial
   c. working
   d. true view
   e. detail

1. What system of projection is used? 1. ______
2. What material is the part made of? 2. ______
3. What pattern was used to cast the part? 3. ______
4. What is the tolerance on fractions? 4. ______
5. Which dimensions are not for machining? 5. ______
6. Which dimension is expressed by limits? 6. ______
7. Determine the following dimensions in inches 7.

A ______
V ______
H ______
P ______
W ______

8. Determine the following dimensions in millimeters 8.

S ______
T ______
U ______
V ______
W ______

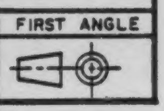


conversion table

	mm	inch
A	114.3	4 1/2
B	130.2	5 1/8
C	123.8	4 7/8
D	41.3	1 5/8
E	88.9	3 1/2
F	69.8	2 3/4
G	34.9	1 3/8
H	19.05	3/4
I	38.1	1 1/2
J	22.22	7/8
K	4.8	3/16
L	41.3	1 5/8
M	82.6	3 1/4
N	13.5	17/32
O	28.6258 28.575	1.127 1.125
P	—	1/8 NPT
Q	6.4	1/4
R	63.5	2 1/2

MAKE FROM SPT 10017
MATL.: CAST STEEL
2 REQD.
TOLERANCES: ± 1.5mm - ± 1/16 in.

FIRST ANGLE



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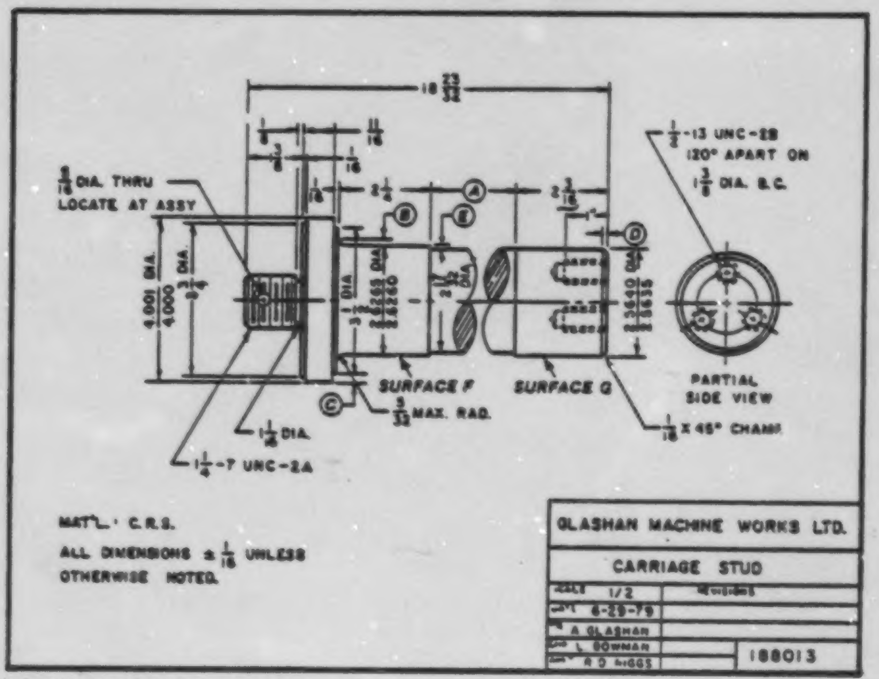
MODULE 1.0 - UNIT 1.0H BASIC BLUEPRINT READING

REVIEW THE DRAWING AND ANSWER THE FOLLOWING QUESTIONS.


$18\frac{23}{32}$
$\frac{1}{8}$
$\frac{11}{16}$
$\frac{3}{8}$
$\frac{1}{16}$
$\frac{1}{16}$
$2\frac{1}{4}$
A
$2\frac{3}{16}$
$\frac{5}{16}$ DIA. THRU
LOCATE AT ASSY
B
E
D
4.001 DIA.
4.000
$3\frac{1}{4}$ DIA.
$3\frac{1}{4}$ DIA.
2.6265 DIA.
2.6260
$2\frac{1}{2}$ DIA.
2.5640 DIA.
2.5635
SURFACE F
SURFACE G
C
$\frac{3}{32}$ MAX. RAD.
$1\frac{1}{16}$ DIA.
$1\frac{1}{4}$-7 UNC-2A
$\frac{1}{2}$-13 UNC-2B
120° APART ON
$1\frac{3}{8}$ DIA. B.C.
PARTIAL
SIDE VIEW
$\frac{1}{16}$ X 45° CHAM.
MAT'L.: C.R.S.
ALL DIMENSIONS ± $\frac{1}{16}$ UNLESS
OTHERWISE NOTED.
GLASHAN MACHINE WORKS LTD.
CARRIAGE STUD
1/2
6-29-79
A GLASHAN
L BOWMAN
R D HIGGS
188013

1. What is the drawing number?
2. What is the name of the part?
3. What revision is the drawing?
4. What material is the part made from?
5. Name the views shown.
6. List the different kinds of lines used on the drawing .
7. What is the scale of the drawing? (Is the scale .... architect's, metric, etc.,?)
8. Determine dimensions A-D.

   A   C

   B   D
9. Which dimension is not to scale?
10. What is the maximum size of the 4 inch collar?
11. Determine the minimum value for dimension E.
12. If surface F was machined to a diameter of 2.62605, would it be within the allowable tolerance?
13. If surface G was machined to a diameter of 2.5040, would it be within the allowable tolerance?
14. What is the diameter of the bot cirlce for the 1/2 - 13 tapped holes?
15. How deep are the 1/2 - 13 tapped holes?

BEST COPY AVAILABLE

TRUE-FALSE:

( ) ( ) 1. Outside calipers can be used to measure the diameter of holes and round stock

( ) ( ) 2. When checking work with a Dial Indicator, a clockwise movement of the pointer hand indicates an increase in part size.

( ) ( ) 3. An variation in part size less than .001 cannot be determined accurately from a Dial Indicator.

( ) ( ) 4. Dial indicators are frequently used, not only for checking machined parts for size vairiations but also in the setup of such parts before machinging.

( ) ( ) 5. A vernier caliper cannot be used to measure parts where an accuracy greater than .001 is required.

MULTIPLE CHOICE:

6. The amount of tolerance generally permitted on all scale measurements is plus or minus _____________.

   a. .625
   b. .03125
   c. .0156

7. The best rule to use when measuring the diameter of round stock is the _______________.

   a. plain steel rule
   b. outside micrometer
   c. slide caliper rule

8. Each graduation of line on the thimble of a metric micrometer equals _______________.

   a. .01 millimeter
   b. .1 millimeter
   c. .5 millimeter

9. To obtain a reading of 6 millimeters on a metric micrometer, starting from the closed position of a zero reading, the thimble must be turned in a connter-clockwise direction _______________________.

   a. 6 complete revolutions
   b. 12 complete revolutions
   c. complete revolutions

COMPLETION:

10. The ____________________ of a combination set is frequently used to lay out centerlines on the end of round stock.

11. A ______________ ______________ gage is a tool used in laying out work to an accuracy of .001.

12. The Vernier Caliper is capable of reading to ____________ inch.

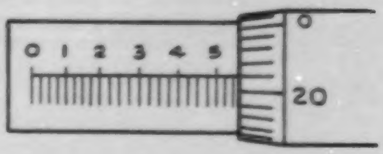
13. The universal Bevel Protractor uses a __________ to accurately measure the parts of a circle.

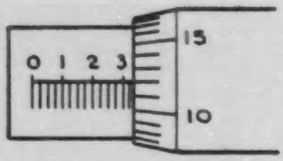
14. __________________ are used in layout work to raise the work to a suitable height and provide a solid, accurate seat.

15. An ___________________ caliper generally is used to measure the diameter of holes or spaces between two-round shafts.

PERFORMANCE TEST:

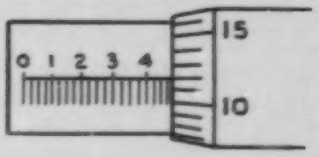
1. DIRECTIONS: STUDY THE MICROMETER CALIPER READINGS THEN WRITE THE CORRECT READINGS ON THE LINE PROVIDED UNDER EACH ILLUSTRATION.

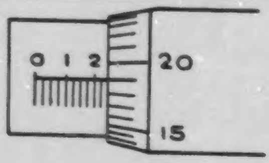




A. ______________________

B. ______________________





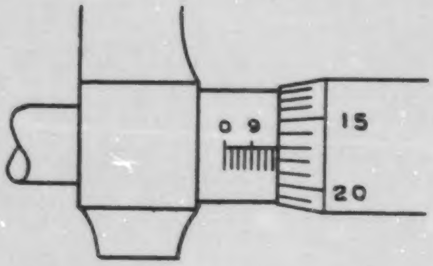
C. ______________________

D. ______________________

MULTIPLE CHOICE:

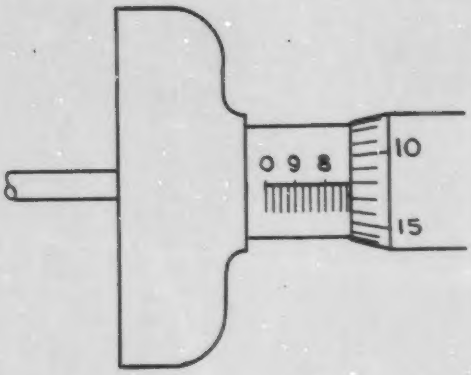
2. The correct reading of this Inside Micrometer Caliper is ________.

   a. .842
   b. .822
   c. .817



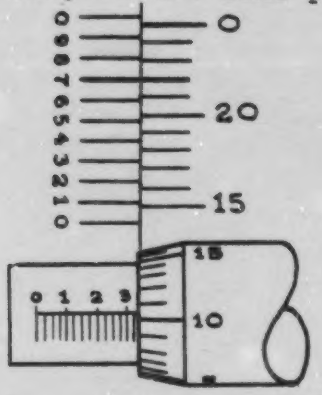
3. The correct reading of this Micrometer Depth Gage is_______.

   a. .712
   b. .718
   c. .825

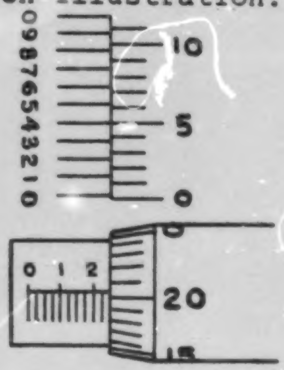


PERFORMANCE TEST:

4. Study the Vernier Micrometer readings then write the correct reading on the line provided under each illustration.


0 9 8 7 6 5 4 3 2 1 0
0
20
15
15
10
0 1 2 3

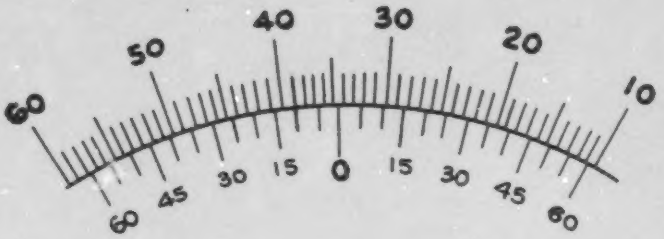
A. ______________________


0 9 8 7 6 5 4 3 2 1 0
10
5
0
0 1 2
20
15

B. ______________________

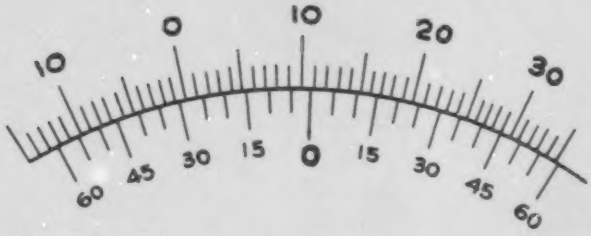
5. The correct reading of this Vernier Bevel Protractor is ________.

a. 30°15'
b. 35°10'
c. 34°10'


60
50
40
30
20
10
60
45
30
15
0
15
30
45
60

6. The correct reading of this Vernier Bevel Protractor is ________.

a. 29°40'
b. 10°45'
c. 11°34'


10
0
10
20
30
60
45
30
15
0
15
30
45
60

UNIT 3.0 WORK LAYOUT

COMPLETION:

1. To layout work is to scribe lines on metal, to show the areas to be ________________.
2. Layout work must be performed on a ____________ ______________. to insure an accurate layout.
3. The tool used to draw a straight line parallel to the edge of a rule is called a ____________________.
4. Center punches are used in layout work to locate and mark the centers of ____________________________.
5. The tool used in laying out center lines on round shafts is called a ______________________________rule.
6. The tool used to scribe a circle in laying out a hole is called a _______________________.
7. Work which must be held in a vertical position for laying out should be clamped to an ________________ ______________.
8. The correct height adjustment of a surface gage must be obtained from the rule of a ________________ ________________.
9. When dimesions are given on the print in inches or fractions, the acceptable accuracy is +/- ____________inches.
10. Measurements with a rule are not taken directly from the print because of ____________________errors.

MULTIPLE CHOICE:

11. Correct layout work is important to maintain: ________

    a. workpiece accuracy
    b. reduced scrap parts
    c. interchangeability of parts
    d. all of the above

12. Which of the following statements best describes layout? ________

    a. Measuring from a print and transferring these measurements to the workpiece.
    b. Measuring the workpiece and comparing this measurement to the print.
    c. Scribing of lines on the workpiece surfaces.
    d. Making a detail drawing on the workpiece.

13. When laying out a casting, which of the following is done first? ________

    a. Establish reference centerlines.
    b. Fill the center of the casting with a piece of tin to provide for centerlines.
    c. Measure the overall casting.
    d. Layout the outline lines from the centerlines.

14. Which of the following surfaces can be laid out to a finer degree of accuracy? ________

    a. Rough surfaces
    b. Machined and finished surfaces
    c. square surfaces
    d. Round surfaces

15. Which of the following tools is used to transfer machining locations when making multiple parts? ________

    a. Beam trammels
    b. Dividers
    c. Hermaphrodite calipers
    d. Templets

PEROFRMANCE TEST:

1. Demonstrate ability to:
    a. Use steel rule.
    b. Use steel rule to set caliper and divider.
    c. Use combination set.
2. Demonstrate ability to:
    a. Use outside vernier micrometer.
    b. Use the depth micrometer.
    c. Use the inside micrometer.
3. Demonstrate the ability to:
    a. Use vernier caliper to take inside, outside, and depth measurements.
    b. Use the depth vernier.
    c. Use the vernier height gage for layout and inspection.
    d. Use the universal bevel protractor to measure angles.
4. Demonstrate ability to:
    a. Use gage blocks
    b. Use sine bar to set angle
5. Demonstrate ability to perform file and spark test.

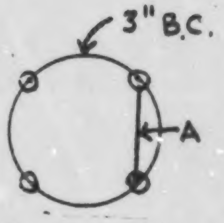
NOTE: RATE EACH PERFORMANCE DEMONSTRATED:

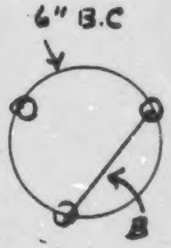
PERFORMANCE RATING

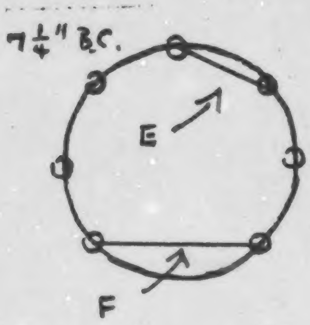
1. 0 / 1 / 2 / 3 / 4
2. 0 / 1 / 2 / 3 / 4
3. 0 / 1 / 2 / 3 / 4
4. 0 / 1 / 2 / 3 / 4
5. 0 / 1 / 2 / 3 / 4

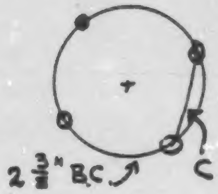
PERFORMANCE TEST:

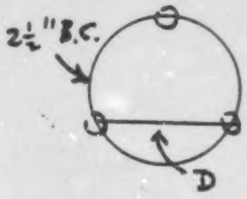
1. Chord A is ______ inches long.
2. Chord B is ______ inches long.
3. Chord C is ______ inches long.
4. Chord D is ______ inches long.
5. Chord E is ______ inches long.
6. Chord F is ______ inches long.



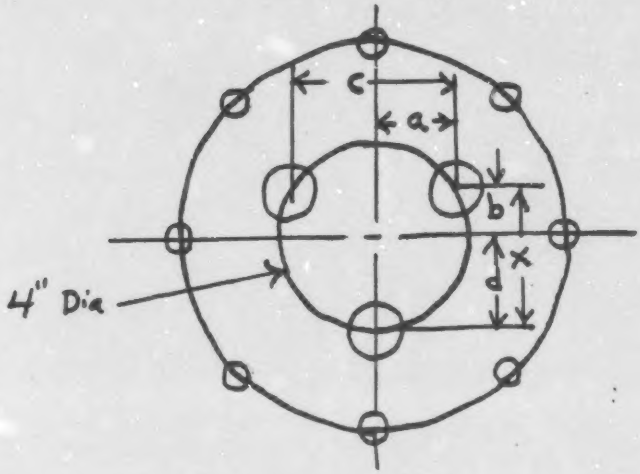








7. A machinist must make a cover plate to fit a hole pattern. The diameter of the smaller circle is 4 inches. Find each dimension to the nearer thousandth inch. (illustration below)



Dimension a ____________

Dimension b ____________

Dimension c ____________

Dimension d ____________

Dimension x ____________

UNIT 4.0 BENCHWORK - HAND TOOLS

MATCHING:

DIRECTIONS: MATCH THE TERMS ON THE RIGHT WITH THE STATEMENTS ON THE LEFT.

________1. Easy to break

________2. Angled surface

________3. Pointed end of a file

________4. Process of making metal resistant to wear

________5. Enlarged area on end of a chisel, caused by striking it with a hammer

________6. Sharp edge left on a metal part from a machining operation

________7. Cutting action of a tool

________8. Semi-precision steel rule with graduations

________9. Side from which dimensions are taken or made

________10. Tool used to produce external threads

a. Chipping
b. Mushroom
c. Tang
d. Shearing
e. Drawfilling
f. Burr
g. Hardening
h. Brittle
i. Reference Surface
j. Tap Drill Size
k. Threading Die
l. Scale
m. Chamfer

ANSWER KEY:

1. h
2. m
3. c
4. g
5. b
6. f
7. d
8. l
9. i
10. k

IDENTIFY:

DIRECTIONS: GIVEN DRAWINGS OF HAND TOOLS COMMON TO MACHINE SHOP WORK OR GIVEN A DISPLAY OF ACTUAL TOOLS, IDENTIFY THE TOOLS USING THE PROPER TERMINOLOGY. THE STANDARDS OF THE INSTRUCTOR MUST BE MET.

COMPLETION:

1. A file which has parallel rows of teeth that cross one another is called a ____________ ________________file.

2. When "rough" filing, apply pressure only on the _______________ stroke of the file, to prevent dulling the teeth.

3. A wrench which had on solid jaw and one movable jaw is called an _____________________wrench.

4. A hole which does not go entirely through a workpiece is referred to in the shop as a __________________hole.

5. A tool used to finish drilled holes accurately to size is called a ______________________.

6. The main function of a _______________is to hold and turn nuts, bolts, cap screws, etc.

7. The ____________ punch is used to line up holes in workpieces.

MULTIPLE CHOICE:

8. The strength of a steel and its ability to hold a cutting edge is largely determined by the content of:

   a. silicon
   b. sulfur
   c. carbon
   d. phosphrous

   Ans.______

9. High-speed steel is a common:

   a. alloy steel
   b. carbon steel
   c. drill rod
   d. wrought iron

   Ans.______

10. A right-hand threaded fastener advances into a part by turning it in which direction?

    a. Clockwise
    b. Backward
    c. Counterclockwise
    d. Forward

    Ans.______

11. Five marks on the head of a bolt would indicate that the strength of the bolt is:

    a. low
    b. medium
    c. high
    d. very high

    Ans._____

12. Which of the following is most commonly used to position or hold a pulley, gear, or collar to a shaft?

a. Stud bolt
b. Castellated nut
c. Thumb screw
d. Set screw

Ans.______

13. What fastener is used to prevent free rotation of a gear or pulley on a shaft?

a. Key
b. Cotter pin
c. Lock washer
d. Flat washer

Ans.______

14. The main difference between a standard and a Phillips head screwdriver is:

a. the size of the shank
b. the length of the shank
c. the shape of the tip
d. the shape of the handle

Ans.______

15. The flat, cold chisel should have the cutting edge slightly ground in which of the following ways?

a. Convex
b. Concave
c. Square
d. Triangle

Ans.______

16. The part of a chisel to watch while chipping is the:

a. head or anvil
b. body
c. cutting edge
d. Hammerhead

Ans._____

17. The process of scraping is used mainly to produce work surfaces that are:

a. flat and smooth
b. square and clean
c. even-grained
d. spotted

Ans.______

18. A mill file is which of the following?

a. Square
b. Milled
c. Double cut
d. Single cut

19. Contersinks for tapered screw heads have an included angle of:

a. 82 degrees Ans.______
b. 70 degrees
c. 60 degrees
d. 120 degrees

20. Twist drills for general-purpose drilling have an included angle of:

a. 90 degrees Ans.______
b. 118 degrees
c. 135 degrees
d. 187 degrees

21. Which of the following is recommended cutting speed for hand hacksawing?

a. 40-50 strokes/minute Ans.______
b. 60-70 strokes/minute
c. 70-80 strokes/minute
d. 80-90 strokes/minute

22. Which of the following hacksaw blade teeth per inch is used for general purpose cutting?

a. 14 teeth/inch Ans.______
b. 18 teeth/inch
c. 24 teeth/inch
d. 32 teeth/inch

23. Broches are fed tothe correct depth with:

a. rods Ans.______
b. pins
c. shims
d. keys

24. Accurate threads are produced only when the tap or die is started:

a. at an angle to the work Ans.______
b. square with the work
c. beveled with the work
d. countersunk with the work

25. External threads are hand cut with the use of a:

a. tap Ans.______
b. die
c. threaded pitch gage
d. countersink

PERFORMANCE TESTS:

1. Given a tool box or set of typical hand tools used in machine shop benchwork, manufacturer's standards concerning proper use and care of hand tools; demonstrate how to care for and use the hand tools to the manufacturer's or instructor's standards.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

2. Hand file a given workpiece within a tolerance of +/- 1/64 inch on fractional dimensions, +/- 0.005 inch on decimal dimensions, +/- 1 degree on angular dimensions, or to given blueprint specifications.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

3. Cut given materials using a hacksaw in a given time to within 1/32 inch outside of scribed line and according to drawing or blueprint.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

4. Given a blueprint, drawing, or other information, and measuring instruments, arbor press, and workpiece; remove and replace parts using the arbor press. Correct tolerance must be observed. Parts must not be damaged. Performance must be to the instructor's standards.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

5. Given blueprint or drawing, arbor press, workpiece, broaching tools, and necessary equipment; hand broach an internal keyway within a tolerance of +/- 0.001 inch on decimal dimensions and +/- 1/64 inch on fractional dimensions or to specifications. Performance must be to the standards of the instructor.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

6. Given a workpiece, blueprint/drawing/specifications, and the necessary hand tap, tools, and materials; cut threads with hand tap so the workpiece will fit a gage or matting screw.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

PERFORMANCE TESTS:

7. Hand ream holes in a given workpiece to specifications. Performance must be to the instructor's standards.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

8. Remove broken drills and taps using bench hand tools so that workpiece meets specifications.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

9. Remove damaged/broken studs/screws/bolts from workpiece using hand tools and restoring the original tapped hole to specifications.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

10. Given specifications and tools and materials, cut by hand a thread on the workpiece. The threaded work must be to specifications.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

UNIT 5.0 BASIC GRINDING

COMPLETION:

1. When a grinding wheel becomes dull it generates excessive ____________________.

2. The usual method for extracting material from the eye is ____________________.

3. If a work piece is small and soft or thin, instead of being ground it should be ________________.

4. Fingers can easily be trapped if ______________ are worn.

5. If there is any questions about a grinding wheel's soundness, it should be ____________________ tested.

6. Off-center wheels will cut only the __________ point of the stone.

7. It is not safe to have ________________ on when grinding.

8. When you start a grinding wheel, it is best to stand to one __________________.

9. A safe, intelligent worker does not grind on the ___________ of a wheel.

10. The water pot is for the ________________ of the work piece.

TRUE-FALSE:

( ) ( ) 1. It is considered an acceptable practice to grind on the sides of a grinding wheel.

( ) ( ) 2. Pliers are acceptable for holding a work piece when grinding.

( ) ( ) 3. If the wheel passes the ring test, it is always safe to use.

( ) ( ) 4. It is safe practice to hold your work piece with a rag.

( ) ( ) 5. Never remove the paper from the sides of the grinding wheel.

( ) ( ) 6. When grinding, gently force material into the wheel.

( ) ( ) 7. When sharpening a tool on the grinding wheel, cool the tool by dipping it in water or allow it to cool in the air.

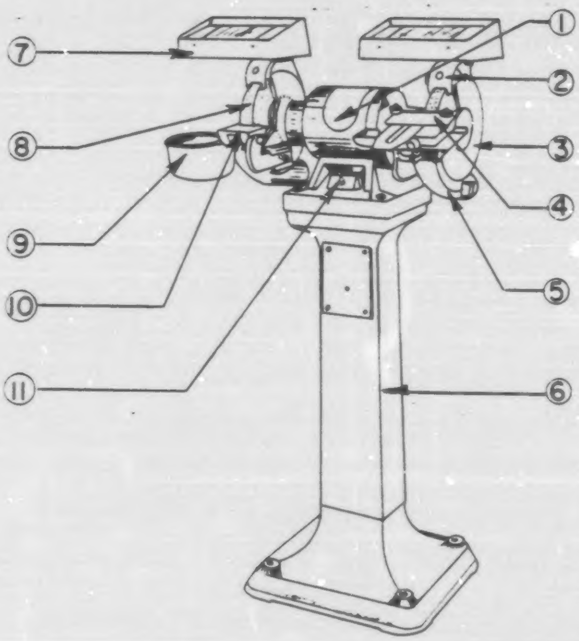
( ) ( ) 8. A combination square can be used to check if the face of the grinding wheel is square with its side.

( ) ( ) 9. Before dressing the grinding wheel, adjust the tool rest on the grinder to a point even with the center of the wheel.

( ) ( ) 10. A 60-grit wheel is suitable for general tool sharpening.

IDENTIFY:

DIRECTIONS: Identify the parts marked on the pedistal grinder illustrated below. Spell the parts correctly.



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________

MULTIPLE CHOICE:

1. The tool rest should be kept within __________ of the wheel.

   a. 1/32 inch
   b. 1/16 inch
   c. 3/32 inch
   d. 3/8 inch

2. Grinding wheels generally rotate at speeds of ____________.

   a. 30 m.p.h.
   b. 50 m.p.h.
   c. 75 m.p.h.
   d. 60 m.p.h.

3. Do not use a grinding wheel that is worn to less than _________ its original diameter.

   a. 3/4
   b. 1/2
   c. 1/4
   d. 80%

4. A grinding wheel that has become loaded should be ___________.

   a. shaped
   b. glazed
   c. dressed
   d. trued

5. Which is not an abrasive used in grinding wheels: _________

   a. Aluminum oxide
   b. Crocus
   c. Fiber
   d. Emery

SHORT ANSWER:

1. Identify the difference between the bench and pedestal grinders.

2. State the reason for the left-hand thread on the left end and right-hand thread on the right end of the grinder shaft.

3. What are the two basic types of abrasive grains used to make grinding wheels?

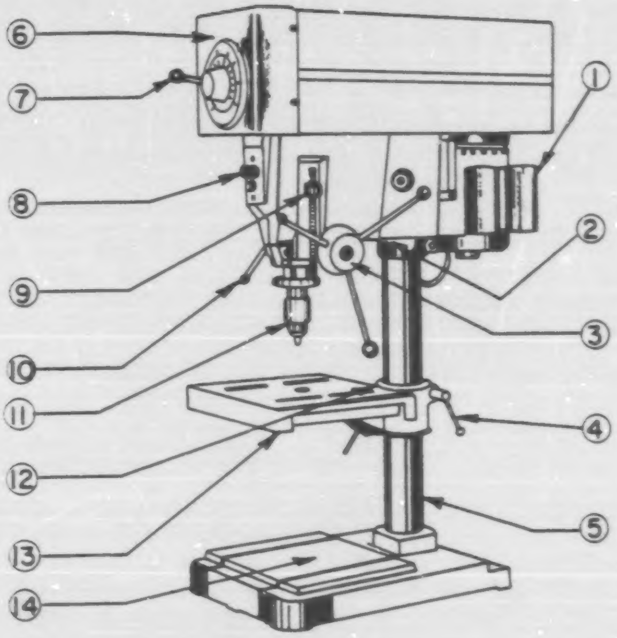
4. State the two reasons why it is important to use blotters when mounting a grinding wheel.

5. What is the first step in grinding a screwdriver blade?

UNIT 6.0 DRILL PRESS

IDENTIFY:

Identify the parts of the drill press illustrated below.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10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________

UNIT 6.0 DRILL PRESS

MULTIPLE CHOICE:

1. The sleeve of a drill press:

   a. holds the cutting tool Ans._______
   b. rotates the spindle
   c. covers the arm
   d. carries the spindle

2. The spindle of a drill press:

   a. never moves Ans._______
   b. supports the workpiece
   c. holds the cutting tool
   d. holds the head

3. The purpose of the flutes is to:

   a. lighten the drill Ans._______
   b. reduce friction
   c. provide a thin web
   d. allow chips to escape from the hold

4. The true diameter of a drill is measured across the:

   a. body clearance Ans._______
   b. web
   c. margins
   d. lips

5. For normal work, the included angle of a drill point should be:

   a. 59 degrees Ans._______
   b. 118 degrees
   c. 135 degrees
   d. 90 degrees

6. A large dead center will:

   a. do a better job Ans._______
   b. reduce wear
   c. increase friction
   d. reduce friction

7. A dull drill may:

   a. slide Ans._______
   b. produce a rough finish
   c. cut undersized holes
   d. not rotate

MULTIPLE CHOICE:

8. Drill lip angle should be checked with a:

   a. center gauge Ans.______
   b. plug gauge
   c. drill gauge
   d. micrometer

9. Drills with worn margins:

   a. can still be used Ans.______
   b. are normal
   c. will slip in the chuck
   d. should be reground or replaced

10. If the drill margins are worn, the drill will measure:

   a. oversize Ans.______
   b. undersize
   c. full size
   d. the same

11. When using the drill press, the most common holding device is a:

   a. strap Ans.______
   b. C clamp
   c. angle plate
   d. vise

12. Step blocks support one end of a:

   a. vise Ans.______
   b. strap
   c. V block
   d. angle plate

13. The slot at the small end of the tapered spindle hole holds the:

   a. shank Ans.______
   b. tang
   c. sleeve
   d. key

14. A ______________ is used to remove toolholding devices from the spindle.

   a. drill chuck Ans.______
   b. drill drift
   c. drill socket
   d. drill sleeve

MULTIPLE CHOICE:

15. Straight shank tools are most often held in a:

a. socket Ans.______
b. drill chuck
c. sleeve
d. spindle hole

16. In drilling, the prupose of spotting a hole is to:

a. increase accuracy Ans.______
b. eliminate setups
c. reduce the drill load
d. save time

17. The rate of speed for spotting should be:

a. automatic, heavy feed Ans.______
b. automatic, light feed
c. hand, heavy feed
d. hand, light feed

18. The most important step in drilling is:

a. layout Ans.______
b. spotting
c. setup
d. drilling

19. Most drill failures result from:

a. too much feed Ans.______
b. too much speed
c. poor tool condition
d. hard material

20. Too much speed will:

a. dull tool edges Ans.______
b. clog flutes
c. cause stress
d. produce heavy chips

21. Too much feed will:

a. prevent the drill from cutting the work Ans.______
b. produce and oversize hole
c. clot the flutes
d. break the outer corners

MULTIPLE CHOICE:

22. A rough hole is the result of: Ans._______

    a. too much speed
    b. too much feed
    c. both a and b
    d. neither a or b

23. Chipped cutting edges result from: Ans._______

    a. too much speed
    b. insufficient feed
    c. insufficient lip clearance
    d. too much lip clearance

24. An 82 degree countersink is mainly used for: Ans._______

    a. burr removal
    b. center reaming
    c. beveling a hole to be tapped

25. A 60 degree countersink is used mainly for: Ans._______

    a. burr removal
    b. center reaming
    c. beveling a hole to be tapped
    d. flathead screws

UNIT 6.0 DRILL BIT SPEEDS

CALCULATE THE PROPER RPM FOR THE FOLLOWING HOLE SIZE AND MATERIAL COMBINATIONS. USING THE FORMULA: $\text{rpm} = \frac{\text{sfm} \times 12}{D'' \times \pi}$ $\pi = 3.14$

MATERIAL	DRILL SIZE	DRILL RPM
1. Low-carbon steel	1/2"	________
2. Cast iron, soft gray	1/4"	________
3. Brass	9/16"	________
4. Slate	1/4"	________
5. Bronze	5/8"	________
6. Low-carbon steel	5/16"	________
7. Medium-carbon steel	5/16"	________
8. Alloy steel	1/2"	________
9. Bakelite	3/16"	________
10. Wood	3/8"	________

CALCULATE THE PROPER RPM FOR THE FOLLOWING PROBLEMS USING THE SHORT-CUT FORMULA: $\text{rpm} = \frac{4 \times \text{sfm}}{D''}$

11. Low-carbon steel	1/2"	________
12. Cast iron, soft gray	1/4"	________
13. Brass	9/16"	________
14. Slate	1/4"	________
15. Bronze	5/8"	________
16. Low-carbon steel	5/16"	________
17. Medium-carbon steel	5/16"	________
18. Alloy steel	1/2"	________
19. Bakelite	3/16"	________
20. Wood	3/8"	________

COMPLETION:

1. The operation of providing a recess at the top of a drilled hole for a flat-head machine screw is called ________________.

2. The operation of providing a recess for the head of a fillister-head screw is called ______________________.

3. A tool used to finish drilled holes to exact size is called a ______________________

4. The operation fo providing a smooth seat or bearing surface around a previously drilled hole for a washer or nut is called ___________________________.

5. Reamed foles must be drilled _____________inch less than the reamed size specified on the drawing.

PERFORMANCE TEST:

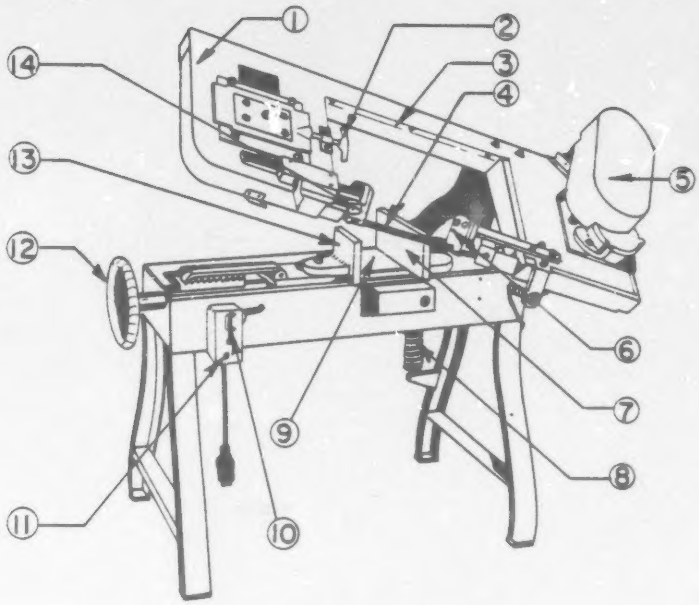
Given a drill press, assortment of drill bits, necessary tools and materials, layout, and workpiece; select the proper bits for the job and drill the workpiece to print specifications. The process and product must meet the instructor's standards.

PERFORMANCE RATING

0 / 1 / 2 / 3 / 4

IDENTIFY:

1. Identify the parts on the metal cutting band saw illustrated below.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5. ______________________

6. ______________________

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8. ______________________

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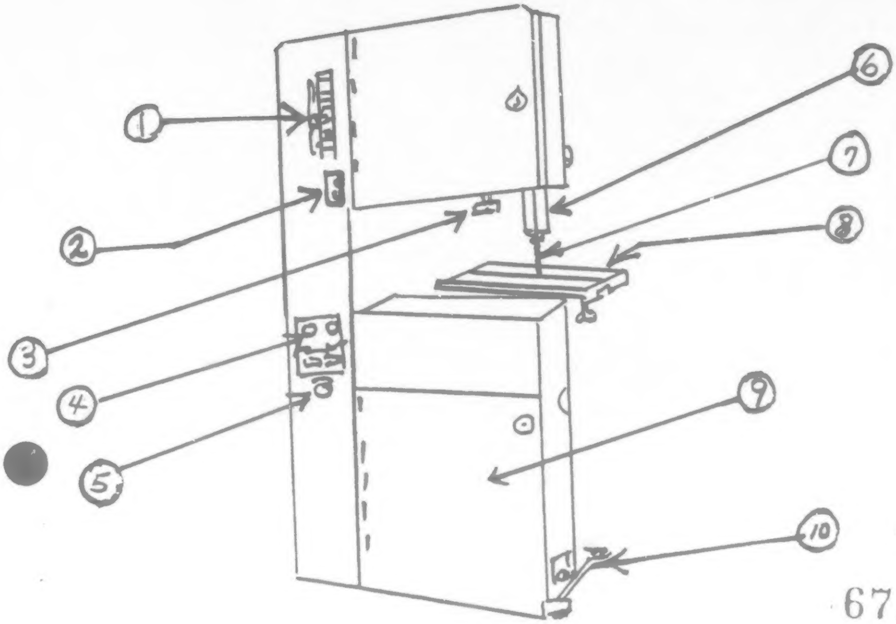
11. ______________________

12. ______________________

13. ______________________

14. ______________________

2. Identify the parts on the metal cutting band saw illustrated below.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1. ______________________

2. ______________________

3. ______________________

4. ______________________

5. ______________________

6. ______________________

7. ______________________

8. ______________________

9. ______________________

10. ______________________

COMPLETION:

1. When laying out the contours of a part for sawing, it is advisable to ____________________ __________________ the layout line, as the layout line may rub off.
2. The wearing of ______________ ________________ is always advisable when operating a band saw.
3. When band sawing a part to a contoured layout line and a filed finish is required, the saw cut should be made __________ ______________ outside of the layout line.
4. When welding saw blades, the overlaping of the saw blade ends can be prevented by proper ______________ adjustment.
5. Band sawing parts to some irregular shape or form following a layout line is called __________________ sawing.
6. Starting holes which are used when band sawing holes in piece parts, should always be drilled ____________________ to the layout line for the hole.
7. Band sawing a multiple number of piece parts from sheet stock is referred to as ____________________ sawing.
8. A power saw with a reciprocating cutting motion is called a power ______________________.
9. Contoured or curved cuts can only be performed on ____________ type band saw machines.
10. To eliminate the brittleness which occurs due to the welding of a band saw, the weld must be ____________ ________.

SHORT ANSWER:

1. State the reason why the band saw blade must be clean of oil before butt welding.

2. After the blade is welded, state the two additional steps that must be done before using the blade.

3. State the four main advantages of the metal-cutting band saw.

4. State the two methods of changing speed on power saws.

5. Give one correct reason for using a cutting fluid when band sawing.

PERFORMANCE TEST:

Given a vertical band saw with blade installed, workpiece, print or specifications, and all materials needed; saw the workpiece according to specifications/plans. Layout must be properly accomplished and work must meet the instructor's standards.

UNIT 8.0 ENGINE LATHE

COMPLETION:

1. The unit of a lathe which houses the lathe spindle and control levers for speed selection is called a ________________.

2. When drilling work on a lathe, mount the drill in the spindle of the ________________________.

3. When mounting any large or heavy chuck on the lathe spindle, it should be supported or held in a ____________ ____________ on the lathe bed until it is secure on the spindle.

4. Lathe work which can not be held in a lathe check can be clamped to a __________mounted on the headstock spindle.

5. To take up wear on the cross slide of compound rest, the adjustable ________________must be tightened.

6. The angle on the face of top surface of a tool which slants from the side cutting edge is called a _________ _________angle.

7. The angles ground into the sides of lathe tools are called relief or ______________angles

8. A round-nose tools ground with no ______________rake can be used as a right- or left-hand tool.

9. To sheck accurately if stock is centered in a four-jaw chick, a _______________________is used.

10. Work which can not be checked. because of its shape can be mounted on a __________________________for facing.

11. The diameter of a finish turned shaft must be checked for size with a __________________________.

12. For a turning operation, the tool bit should be set slightly __________________the center of the stock.

13. The preferred chuck for mounting small cylindrical work to be turned is the ________________________chuck.

14. When cutting off work, the lathe ______________must be locked to the lathe bed.

15. The preferred chuck for mounting small cylindrical work to be turned is the ________________________chuck.

16. Tailstock centers which do not revolve with the workpiece are referred to as ________________________centers.

17. A device which is fastened to the headstock end of a workpiece when work is turned between centers is called a _______________ ___________________________.

18. Workpieces provided with a reamed hole are mounted on a tapered ___________________________for turning between centers.

19. The dovetail surfaces of the compound rest, the carriage, and the cross slides are provided with adjustable _______________ to take up wear.

20. The ground point of a Unified of V-threading tool must be checked for accuracy with a _________________ _______________.

21. The operation of producing and accurately sized hole in a lathe using a tool bit is called a _______________________.

22. The width of the tool bit point for cutting a _______________ thread should be ground to 1/2 the pitch of the thread.

23. Drill chucks when used for drilling operations in a lathe are mounted in the ____________________spindle.

24. A ___________________ ______________________is used to support long, slender, cylindrical workpieces and is attached directly to the ways of the lathe bed.

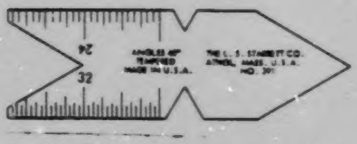
25. The process of checking the surface of a piece of work by rolling depressions into it is called _______________________.

UNIT 8.0 ENGINE LATHE

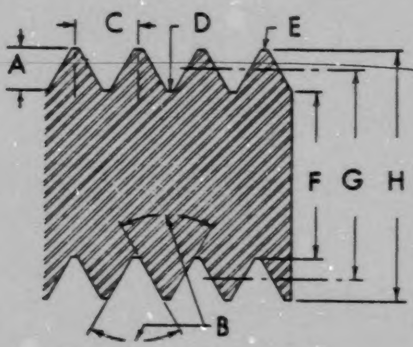
IDENTIFY:

1. The gauge shown in this illustration is used to check the point angle of tool bits for cutting: __________

   a. square threads
   b. Unified threads
   c. Acme threads
   d. worm threads

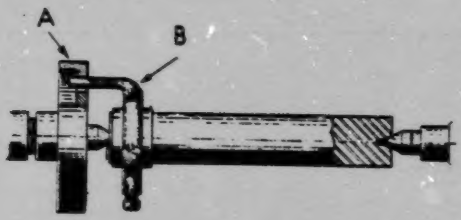


2. Print the letter from the illustration next to the thread term which it represents.



_____ pitch
_____ thread depth
_____ thread crest
_____ root
_____ thread angle
_____ minor diameter
_____ major diameter
_____ pitch diameter

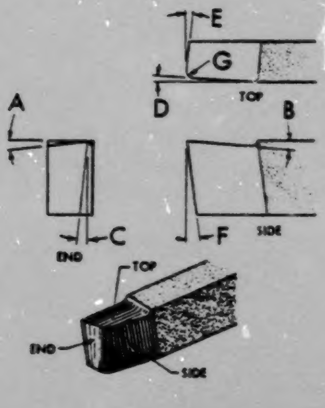
3. Write the name of the two work holding devices which are used when turning or facing work between lathe centers.



A__________ __________

B__________ __________

4. Write the correct letter which corresponds to each tool bit angle named below.



Letter	Angle
_____	back rake angle
_____	side clearance angle
_____	side rake angle
_____	front clearance angle
_____	end cutting-edge angle
_____	side cutting-edge angle

UNIT 8.0 ENGINE LATHE

MULTIPLE CHOICE:

1. Parts having a square or irregular shape to be machined on a lathe can only be mounted in:

   a. universal chucks Ans.________
   b. independent chucks
   c. collet chucks
   d. cam lock chucks

2. Which one of the following lathe parts is not provided with a power feed?

   a. carriage Ans.________
   b. compound rest
   c. cross slide

3. To refinish the points of lathe centers which have become worn, grind them to an included angle of:

   a. 30 degrees Ans.________
   b.. 60 degrees
   c. 90 degrees
   d. 82 degrees

4. Angles which are ground on the top surfaces or face of a lathe tool bit and which slant downward from the side cutting edge of the tool are called:

   a. positive side rake angles Ans.________
   b. negative side rake angles
   c. side clearance angles
   d. end cutting-edge angles

5. Chatter in lathe work which produces a rough surface finish, can be prevented in some cases by regrinding the tool bit to:

   a. increase the side cutting-edge angle Ans.________
   b. reduce the back rake angle
   c. increase the side clearance angle
   d. reduce the side cutting-edge angle

6. Lathe tool bits made of straight tungsten carbide are noted for their ability to resist:

   a. catering Ans.________
   b. galling
   c. wear
   d. shipping

7. When straight turning a shaft mounted between lathe centers:
Ans.______

a. set the compound parallel to the work axis
b. use a lubricant
c. set the tool bit slightly above the work centerline
d. set the tool bit below the work centerline

8. A single thread screw having a pitch of 10 has:

a. 8 threads/inch Ans.______
b. 10 threads/inch
c. 9 threads/inch
d. 6 threads/inch

9. The tool bit used in cutting an Acme thread must be ground to an angle of:

a. 30 degrees Ans.______
b. 29 degrees
c. 14.5 degrees
d. 60 degrees

10. A good lubricant to use in thread-cutting operations is:

a. graphite Ans.______
b. white lead
c. mineral oil
d. water soluble oil

11. What would be the finish depth of a square thread having a pitch of 1/8 inch?

a. 1/2 inch Ans.______
b. 1/8 inch
c. 1/16 inch
d. 3/32 inch

12. Short or sharp angled tapers are machined using:

a. a taper attachment Ans.______
b. the compound rest
c. the tailstock setover method

13. When an internal right-hand unified thread is being cut, the lathe compound is set:

a. parallel to the work axis Ans.______
b. 29 degrees to the left of the cross-slide centerlines
c. 90 degrees ot the work axis
d. 29 degrees to the right of the cross-slide centerlines

14. Of the following factors listed, which one must be considered in determining the proper grade of carbide tool to use?

a. the type of operation to be done Ans.________
b. the type of material to be machined
c. the finish requirements of the machined part
d. the speeds to be used in turning the part

15. The lead of a double-thread screw having 8 threads per inch is:

a. .125 Ans.________
b. .250
c. .110
d. .0625

UNIT 8.0 COMPUTE LATHE RPM

USING THE RPM FORMULA, COMPUTE THE CORRECT RPM FOR THE PROBLEMS:

the rpm formula is: $\text{rpm} = \frac{\text{fpm} \times 12}{\text{Dia}" \times \pi}$ π is 3.14

NOTE: Round your answer ot the nearest revolution per minute.

1. What rpm should be used for a heavy cut of 100 fpm on a piece of low-carbon steel of 1/2" dia.?
2. What rpm should be used for a finish cut of 260 fpm on a piece of low-carbon steel of 2" dia.?
3. What rpm should be used for a heavy cut of 80 fpm on a piece of cast iron of 6" dia.?
4. What rpm should be used for a heavy cut of 125 fpm on a piece of aluminum of 4" dia.?
5. What rpm should be used for a finish cut of 135 fpm on a piece of cast iron of 10" dia.?
6. What rpm should be used for a rough cut of 175 fpm on a piece of brass of 10" dia.?
7. What rpm should be used to make a heavy cut of 80 fpm on a piece of high-carbon steel of 3" dia.?
8. What rpm should be used for a finish cut of 225 fpm on a piece of medium-carbon steel of 3/4" dia.?
9. What rpm should be used for a finish cut of 300 fpm on a piece of aluminum of 24" dia.?
10. What rpm should be used to make a rough cut of 125 fpm on a piece of aluminum of 8 1/2" in dia.?

PERFORMANCE TESTS:

1. (Mount Workpiece between Centers) Given an engine lathe, pre-cut cylindrical stock with scribed centers, a faceplate and dog, combination drill and countersink, detail drawings, specifications, and the necessary tools, materials, and equipment; center drill the workpiece and mount it between the centers. The workpiece must be center drilled to specifications with a tolerance of +/- 0.005 inches for location, diameter, and depth. The workpice must be mounted with the soft center in the live (headstock) center and the hardened center in the dead (tailstock) center to specifications. The tailstock must be fastened securely with room for the saddle and the tool block to operate.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

2. (Turn a Workpiece to Dimensions) Given an engine lathe, cylindrical stock, a detail drawing that requires various diameters, toolholder and bits, and the necessary tools, measuring instruments, and materials; turn the wrokpiece to dimensions. The diameters and dimensions must meet specifications with a tolerance of +/- 0.005 inch.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

3. (Knurl a Workpiece) Given an engine lathe, cylindrical stock, a detail drawing of a knurled part, knurling specifications, diamond and straight knurling tools, and the necessary tools, measuring instruments, and materials; knurl the workpiece to specifications using course, medium, and fine rollers as required. The knurl must meet specifications with a tolerance of +/- 1/64 inch.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

4. (Drill Holes with Lathe) Given an engine lathe, cylindrical parts, a detail drawing of parts to be drilled, drilling specifications, a drill chuck and drill bits, and the necessary tools, measuring instruments, and materials; drill holes in the parts using the lathe tailstock. The holes must be drilled to specifications with a tolerance of +/- .003 inch for location, +.002 inch for diameter, and +/- 1/64 inch for depth.
-.000 inch

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

5. (Machine External Chamfer) Provided with an engine lathe, cylindrical stock, a detail drawing that requires an external chamfer, toolholder and bits, and the necessary tools, measuring instruments, and materials; machine an external chamfer on the stock. The chamfer must be machined to specifications with a tolerance of +/- .0005 inches.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

6. (Part Workpiece) Provided with an engine lathe, culindrical workpieces requiring parting, detail drawings, parting specifications, toolholder and parting tools, and the necessary tools, measuring instruments, and the materials; part the workpieces to specifications with a tolerance of +/- 1/64 inch.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

7. (Grind Workpiece with Tool Post Grinder) Provided with blueprint, workpiece, lathe and accessories including tool post grinder; grind workpiece with tool post grinder to specifications with a tolerance of +/- 0.0005 inches.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

8. (Cut Grooves or Recesses) Given an engine lathe, cylindrical stock, a detail drawing that requires several recesses or grooves (v-shaped, square, and round), groove or neck specifications, toolholder and tool bits, and the necessary tools, measuring instruments, and materials; turn the grooves or necks specified for the stock with a tolerance of +/- ,005 inches,

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

9. (Machine External Taper) Provided with and engine lathe, workpiece, detail drawing requiring external taper, tapering attachment, taper specifications, toolholder and tool bits, and the necessary hand tools, measuring instruments, and materials; machine external taper using tailstock setover method of the tapering attachment. The taper must be machined to specifications with a tolerance of .001 inches per 4 inches.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

10. (Set Up Lathe for Threading Operation) Given the requirement for various threading operations on the engine lathe, a faceplate and dogs, a universal or independent chuck, pre-cut cylindrical stock, toolholder, and single point toll bits, and the necessary hand tools, measuring instruments, and materials; set up the engine lathe for threading operations. All components must be mechanically secure. The tool bit must be secured in the toolholder and set square with the workpiece. The thread chasing dial must be positioned for secified threading operations including even, odd, and fractional divisions. The end of each workpiece must be chamfered with the side of the threading tool to .005 inches below minor diameter of the thread.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

UNIT 9.0 MILLING MACHINE

COMPLETION:

1. To prevent springing the arbor of a horizontal milling machine, the arbor nut should be tightened until the ____________ ______________ is in place.

2. The position of the ___________ is what classifies a milling machine as being horizontal or vertical.

3. The depth of cut in horizontal milling operations is obtained by raising the ______________ which supports the table saddle.

4. The feed screws of a milling machine table are provided with ______________ dials to permit accurate positioning of the table.

5. The attachment used on milling machines for indexing is called a _____________ ______________.

6. The first step in calculating the correct indexing needed for a specific job is to divide the constant __________ by the number of divisions required.

7. The cutters designed for straddle milling operations are called ____________ ________________.

8. The cutting action of a _____________ milling cutter is the same as an end mill cutter.

9. In horizontal milling operations, the _________ feed is used to move the workpiece into or away from the cutter.

10. A style "C" arbor must be used for mounting __________-________________ mill cutters.

11. A quick and accurate way to mill a perfect square on the end of a round shaft is to mount the shaft in a ___________ ______________ so the shaft can be indexed.

12. The accurate spacing of teeth in a gear blank requires the use of a _______________ _____________.

13. The cutting of helical gears requires the use of a _________ ________________ milling machine.

14. A gear tooth vernier caliper is used to measure the __________ and chordal thickness of gear teeth.

15. It is important in milling a helical gear to center the _____________ over the mandrel before the table is set to the helix angle.

UNIT 9.0 MILLING MACHINES

MULTIPLE CHOICE:

1. To index work mounted on a dividing head one complete turn, the index crank must be turned:

    a. forty complete turns Ans.______
    b. twenty complete turns
    c. ten complete turns

2. The number of index crank turns needed after each cut to mill eight equally spaced slots in a round shaft is:

    a. four Ans.______
    b. seven
    c. five

3. Only a universal dividing head can be used to perform a milling operation by:

    a. plain indexing Ans.______
    b. direct indexing
    c. differential indexing

4. When indexing work by degrees, one complete turn of the index crank will turn the workpiece:

    a. 9 degrees Ans.______
    b. 15 degrees
    c. 7 degrees

5. Because the hard scale will dull the cutter teeth, the climb cutting method of cutter rotation should never be used when milling:

    a. tool steel Ans.______
    b. magnesium
    c. cast iron

6. The measuremnt from center to center of adjacent gear teeth taken on the arc of the pitch circle, is called the:

    a. circular pitch Ans.______
    b. chordal pitch
    c. diametral pitch

7. The tooth addendum of a gear having a diametral pitch of 4 is:

    a. .250 Ans.______
    b. .125
    c. .156

8. What would be the proper number of form cutter to use in milling a gear with 36 teeth?

a. No. 6 cutter Ans.______
b. No. 3 cutter
c. No. 5 cutter

9. Helical milling operations can be performed only on a:

a. plain horizontal milling machine Ans.______
b. vertical milling machine
c. universal milling machine

10. The circumference of the gear blank must be divided by the lead of the helix in helical milling to determine the:

a. angle setting of machine table Ans.______
b. proper speed use
c. proper feed and depth of cut needed

PERFORMANCE TESTS:

1. (Align Workpiece, Mill Head, Machine Attachemtns, and Fixture) Given the milling machine, vise, attachments, clamping bolts, wrench, measuring instruments, mallet, squire, workpiece, blueprint/drawing/specifications for task, and other materials needed; align vise, machine attachments, mill head, and workpiece to specifications acceptable in the local machining industry and to the instructor.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

2. (Calculate Cutting Speeds and Feeds for Milling Machine Work) Given a milling machine and accessories, workstock, work assignment, and the necessary tools and materials; select proper cutter and attachment, calculate speed and feed, and install the cutter. Performance must conform to the Machinery's Handbook.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

3. (Face Mill Workpiece) Given a milling machine with workpiece mounted in a jig, detail drawing or blueprint, facing specifications, an assortment of arbors, collars, and milling cutters, and the necessary hand tools, measuring instruments, and materials; face mill the workpiece to specifications to a tolerance of +/- .001 inches. Finished work must be smooth without gouges or marks.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

4. (Perform Keyseating and T-Slot Milling Operation) Given milling machine, blueprint-drawing, specifications, workpiece and precision measuring instruments, and necessary tools and materials; machine a Woodruff keyway (seat) in the workpiece with a tolerance of +/- ,005 inshes to specifications (+/- 1/64 inch fraction dimensions).

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

5. (Perform Indexing Operations) Given milling machine, indexing or dividing head, rectangular or cylindrical stock, detail drawing that requires equally spaced slots milled in workpiece, milling specifications, assortment of milling cutters and holders, and the necessary hand tools, attachments, measuring instruments, and materials; mill slots to specifications +/- .002 inch for location and +/- .001 inch for width and depth. Performance and product must be to the standards of the instructor.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

6. (Mill a Gear Rack) Given the milling machine, drawing, specifications, workpiece, machine accessories and cutters, and necessary tools, measuring instruments, and materials; mill a gear rack to specifications, tolerance of "zero" to .002 inches. Performance and product must meet instructor's standards.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

7. (Machine a Spur Gear) Given a detail drawing , a precut workpiece, hand tools, precision measuring instruments, and the necessary machine tools, accessories, attachments, and materials; machine a spur gear. The gear must meet the specifications of the drawing with a tolerance of +/- .002 inches for pitch diameter and dimensions. Performance and product must be to the instructor's standards.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

COMPLETION:

1. Stock to be machined on bar-type turret lathes is held or gripped in __________________chucks.

2. Turret lathes so contructed that turning cuts are made by moving the saddle along the bedways of the machine are classified as _______________type machines.

3. A tool which is mounted in the hexagon turret for taking heavy turning cuts at high speeds is called a __________ _______________.

4. A drill having flat sided and two cutting edges for drilling large holes is called a ________________drill.

5. When reaming holes with sloid reamers, mount the reamer in a __________________holder.

6. The use of a ___________________tap when large holes are being threaded eliminates having to reverse the rotation of the lathe spindle when withdrawing the tap from the hole.

7. When work from the hexagon turret is being bored, the boring bar holding the tool bit must be mounted in a _______________ ___________________.

8. On a single-spindle screw machines, stock cutoff operations normally are performed from the _______________tool side.

9. Automatic Turret lathes capable of producing identical precision turned parts in large quanities are classified as _________________________machines.

10. The typical tolerance obtained in turning operations on automatic crew machines is plus and minus _____________.

MULTIPLE CHOICE:

1. Taper turning on a turret lathe requires the use of a taper attachment. The turning cut is then taken from the:

   a. square turret Ans.______
   b. hexagon turret
   c. vertical tool side
   d. rear tool post

2. On bar-type turret lathes, work to be machined is gripped or held by:

   a. collet chucks Ans.______
   b. universal chucks
   c. faceplates
   d. independent chucks

3. Turret lathes on which long turning cuts are made by movement of the saddle along bedways of the mchine are classified as:

   a. sadlle-type turret lathes Ans.______
   b. ram-type machines
   c. carriage-type machines
   d. automatic screw machines

4. Internal tapers are checked for accuracy using a:

   a. micrometer Ans.______
   b. telescopic gage
   c. taper plug gage
   d. socket gage

5. Short or sharp angled tapers are machined using:

   a. a taper attachment Ans.______
   b. the compound rest
   c. the tailstock setover method
   d. a form tool ground to the taper angle

UNIT 12.0 SURFACE GRINDING

COMPLETION:

1. The grinder which is used to produce flat ground surfaces is called a ______________________________grinder.

2. The depth of cut on a surface grinder is regulated by raising or lowering the ____________________.

3. Most surface grinders are provided with a ____________________ chuck for holding the work to be ground.

4. The type of grinding which involves feeding the grinding wheel into the workpiece is called_________________.

5. The operation of sharpening a grinding wheel is called wheel _________________________.

MULTIPLE CHOICE:

6. The grinding wheels employed in surface grinding operations are classified as:

   a. plain grinding wheels Ans.______
   b. cup wheels
   c. dished or saucer wheels

7. Grinding machines equipped with rotating worktables are classified as:

   a. tool or cutter grinders Ans.______
   b. cylindrical grinders
   c. surface grinders

SHORT ANSWER:

8. Name three conditions which indicate that a grinding wheel requires dressing.

9. List an advantage and disadvantage of dry grinding. Answers must agree with textbooks or be acceptable to instructor.

10. When should wet grinding be used?

11. Why is surface finish so important in industrial applications?

12. What unit of measurement is used to indicate surface finish?

13. What two types of tables are found on surface grinders?

14. What factors determine the method of hold a workpiece for grinding?

15. Why is it important that the burrs be removed from the workpiece and the chuck face prior to grinding?

16. What two factors are important when properly grinding a flat surface?

17. When is it necessary to balance a grinding wheel?

18. What crossfeed should be used when grinding a falt surface?

19. Why is the table speed reduced when taking a roughing cut?

20. List the procedures for taking a finishing cut on the workpiece when grinding a flat surface?

PERFORMANCE TEST:

1. Given a horizontal spindle surface grinder, operator's instructions, set up specifications, workpieces requiring flat surfaces machined to a surface expressed in micro-inches, dimensioned blueprints or drawings, grinding specifications, grinding wheels, magnetic chuck, and the necessary hand tools, measuring instruments, and materials; set up the surface grinder for flat surfacing operations and grind the flat surfaces to specifications with a tolerance of 32-125 micro-inches. Performance process and porduct must meet the instructor's standards.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

UNIT 13.0 SHAPER

COMPLETION:

1. So that the depth of any cut can be accurately determined, the tool head feed screw is equipped with a ______________ collar graduated in thousandths of an inch.

2. To properly seat work in a shaper vise for machining, the work should be supported on ______________________.

3. The ________________________ of the ram stroke is regulated by turning the stroke adjusting.

4. To obtain an equal spacing of splines around the circumference of a shaft by shaping, the shaft is mounted between ___________ ________________ centers.

5. Shapers equipped with a table that can be swiveled for angle cutting are referred to as ___________________ shapers.

6. Rotary tables for circular cuts are standards equipment on a _____________________ shaper.

7. Safe operating practice requires that the shaper be ________________________ before any changes of machine adjustments or in the work setup are made.

8. When setting up a shaper, the ram stroke must be adjusted for both ____________________ and ________________ over the work.

9. The smoothly finished square or rectangular bars used as
a a workseat support when shaping work in a vise are called ______________________________.

10. The _____________________ is a casting that serves as a foundation for the entire shaper.

UNIT 13.0 SHAPER

MULTIPLE-CHOICE:

1. Shapers equipped with universal rather than the conventional type table are preferred when performing operations such as:

   a. vertical shaping Ans.______
   b. angle shaping
   c. slotting
   d. form cutting gear teeth

2. The clapper box usually is set vertically when taking:

   a. roughing cuts Ans.______
   b. Angular cuts
   c. horizontal cuts
   d. vertical cuts

3. The factor to be considered in determining shaper size is the:

   a. overall height of the machine Ans.______
   b. the table size with which the machine is equipped
   c. The maximum table feed movement
   d. the maximum stroke length of the ram

4. When grinding single point tools for shaper use, what degree of side clearance normally would be provided?

   a. 5 degrees Ans.______
   b. 2 degrees
   c. 15 degrees
   d. 8 degrees

5. To prolong the life of shaper tools after they are ground, they should be:

   a. lapped Ans.______
   b. sanded
   c. stoned
   d. hardened

6. What work holding device would be recommended for use when shaping a keyway in a cylindrical shaft?

   a. v-block Ans.______
   b. angle plate
   c. dividing head
   d. shaper vise

7. To machine a piece of work 5.5 inches long on a shaper, the minimum stroke length which can be used is:

   a. 5.75 inches
   b. 5.5 inches
   c. 6.25 inches

   Ans.______

8. The adjustment of the ram-position shaft on a shaper is done with the ram:

   Ans.______

   a. stopped at the end of the back or return stroke
   b. in motion on the return stroke
   c. stopped midway through the cutting stroke

9. To shape splines in a shaft which must be accurately spaced, the work is mounted:

   a. in a shaper vise
   b. between indexing centers
   c. in V-blocks
   d. in a special fixture

   Ans.______

10. The feed can be hand or power when using the shaper. The amount of feed is based on the:

   a. type of material in the cutting tool
   b. amount of material being removed at each cut
   c. depth of cut

   Ans.______

PERFORMANCE TESTS:

1. (Set Up Shaper for Machining Operations, Set Speed and Feed) Given a horizontal shaper, setup specifications, workpieces, cutting tools and attachments, a dial indicator, and the necessary hand tools, measuring instruments, and materials; set up the shaper for various machining operations. The correct cutting tools must be selected, secured, and aligned. The workpiece, attachments, and cutting tools must be aligned with the table and toolhead to specifications with a tolerance of +/- .001 inch.

   For given shaper operation, calculate speed and feed and set machine up within 10 percent of instructor's calculations, conforming to Machinery's Handbook.

   Set up shaper, align shaper attachments, workpiece, and cutter. Cutting toolhead and side clearnace must be within 4 degrees. Ram stroke must clear workpiece on forward stroke by 1/4 inch, and 1/2 inch on return stroke.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

2. (Make a Rough and Finished Horizontal Cut) Given a horizontal shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal roughing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instruments, and materials; make roughing cuts in workpiece. The stock must be rough cut to specified depth of cut using consecutive 1/8 inch cuts. The roughing cuts must allow for finishing cut of .005 inch.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

3. Given a horizontal shaper with a workpiece mounted using a vise and parallel bars, a detail drawing, shaping specifications for horizontal finishing cuts, an assortment of shaper cutting tools and holders, and the necessary hand tools, measuring instruments, and materials, make finishing cuts in workpiece. The finishing cuts must be made to specified depth of cut using consecutive ,005 inch cuts, with a tolerance of +/- .005 inch for dimensions.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

PERFORMANCE TEST:

1. (Set Up a Tool and Cutter Grinder) Given a tool and cutter grinder, a selection of grinding wheels, operator's instructions, dressing tools, and the necessary equipment and materials; set up the tool and cutter grinder for various grinding operations (e.g., sharpen tool bits). The grinding wheel must run true, and the grinding surface must not be located or glazed. The grinder must operate according to the manufacturer's specifications.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

UNIT 15.0 HEAT TREATMENT

COMPLETION:

1. The steels used in cutting tools of high quality have a ______________________ grain structure.

2. Steel hardens when it is heated and quenched because of the changes which occur in the ________________ structure.

3. The temperature to which steel must be heated so that it will harden when quenched is called the ______________ temperature.

4. Two processed used in case-hardening steel are ______________ and ____________________________.

5. All parts which have been hardened must be ________________ to relieve the hardening strains and to increase the toughness of the part.

MULTIPLE CHOICE:

1. Steel is made form cast iron by removing all excess:

   a. carbon Ans.______
   b. silicon
   c. sulphur

2. The most important factor relative to the physical properties of steel is:

   a. carbon Ans.______
   b. silicon
   c. manganese

3. Machine steel or mild steel are terms commonly applied to steels containing:

   a. more than .40 percent carbon Ans.______
   b. less than .30 percent carbon
   c. more than .50 percent carbon

4. To alloying elements of steel commonly used as purifiers or cleansing agents are:

   a. manganese and silicon Ans.______
   b. vanadium and chromium
   c. molybdenum and nickel

5. Under the color code for marking steel bars so they can be readily identified as to type of steel, a free cutting steel would have the end of the bar painted:

   a. yellow Ans.______
   b. green
   c. brown

6. A test commonly applied to steel of unknown quality for identification purposes is the:

   a. acid-etch test Ans.______
   b. spark test
   c. fracture test

7. High alloy steel must be heated slowly and uniformly for hardening, to avoid:

   a. scaling Ans.______
   b. shrinkage
   c. warpage

8. Case hardening is the only method suitable for hardening:

   a. high slloy steel Ans.______
   b. high carbon steel
   c. low carbon steel

9. When hardening steel by the carburizing process and the steel has been heated to the correct temperature for the correct amount of time, the furnace is shut off and the steel is:

   a. removed and quenched in water Ans.______
   b. left in the furnace to cool
   c. removed and cooled in air

10. Hardening strains created in steel after it has been heated and quenched must be removed by:

    a. tempering Ans.______
    b. annealing
    c. normalinzing

PERFORMANCE TESTS:

1. (Test Workpiece for Hardness) Given an assortment of metal workpieces (steel, unhardened steel, soft-temper steel, and cast iron), test blocks with hardness tester and Comparative Hardness Scales (use Rockwell tests to determine hardness of samples). The correct hardness numbers must be taken from the tests on the samples. Readings must agree with the readings taken by the instructor.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

2. (Harden and Temper Workpiece) Given a furnace for hardening and tempering operations, workpiece(s), quenching solutions, a shart of heat treatment specifications, a hardness testing procedures outlined by the instructor, workbench, file, tongs, and the necessary materials; (a) harden and (b) temper the workpiece(s). The stock must be hardened and tempered to the specifications of the instructor.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

3. (Anneal Workpiece) Given heat treating equipment, hardened workpiece, specifications, and the necessary tools and materials; anneal the workpiece. The stock must be annealed to specifications of the instructor.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

PERFORMANCE TEST: (OPTIONAL)

1. (Set Up, Remove, and Replace Parts with Hydraulic Press) Given specifications/drawing, gears pulleys or wheel, a shaft, etc., with keyway, key, lubricant, clamps, and measuring instruments; set, remove, and replace parts with press to a tolerance of +/- 1/64 inch.

PERFORMANCE RATING
0 / 1 / 2 / 3 / 4

UNIT 17.0 CNC MACHINE

COMPLETION:

1. The two systems of numerical control are ______________-____________________ and the continuous path system.

2. The machine tool to which the system of point-to-point numerical control applies is the ____________________.

3. The numerical control system which applies to a milling machine is called the ________________ ______________.

4. The control unit which commands and guides the movement of numerically controlled machine tools is called a ____________ ______________________.

MULTIPLE CHOICE:

1. The point-to-point system of numerical control can be applied only to:

   Ans.______

   a. ocnventional drill press of jig boring operations
   b. conventioanl milling operations
   c. conventional shaper operations

2. The vertical movement of the table on a conventional milling machine is represented in the Catesian coordinate system as a movement parallel to the:

   a. Z-axis
   b. X-axis
   c. Y-axis

   Ans.______

3. The cross feed movement of a conventional milling machine table is represented in the Cartesian coordinate system as a movement parallel to the:

   a. X-axis
   b. Z-axis
   c. Y-axis

   Ans.______

SHORT ANSWER:

DIRECTIONS: Explain the following terms as used with the CNC Compact 5 Trainer used in machine shop.

1. Longitudinal or cross slide -

2. Direction rate -

3. Feed rate -

4. "Minus" value -

5. Coding -

PERFORMANCE TESTS:

1. (Set Up CNC Program/Machine) Given instruction, blueprint-drawing-specifications, cutting tools, workpiece, precision measuring instruments, student handbook - BASIS, and the CNC trainer; set up the CNC milling machine for machining a given workpiece. The workpiece must be within a tolerance of +/- .001 inch or to specifications.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

2. (Machine Workpiece with CNC Machine) Given the CNC machine, tools, program, workholding devices, measuring instruments, references, blueprint-drawing-specifications, aluminum stock, and the necessary tools and materials; machine the workpiece to specifications within a tolerance of +/- .001 inch of decimal dimensions and +/- 1/64 inch on fractional dimensions.

   PERFORMANCE RATING
   0 / 1 / 2 / 3 / 4

1. (Convert Revolutions Per Minute of Grinding Wheel to Surface Feet Per Minute) Given reference material, calculate surface feet per minute (SFPM) of a grinding wheel. Round off the answer to decimal point. Answer must be within 5 SFPM and maximum speed must not exceed handbook specifications.

2. (Calculate Depths and Widths of Slots and Grooves on Special Setups) Given blueprint references, and workpiece, calculate dimensions of slots and grooves for special setup. A tolerance of +/- 0.001 inches must be obtained in calculations.

3. (Calculate Feeds and Speeds) Given blueprint, workpiece, machinery specifications, milling machine, milling cutter, measuring instruments, and other materials needed; calculate speed and feed. Speed must be within a tolerance of +/- 5 RPM and feed within a tolerance of +/- .001 inches.

4. (Calculate Tolerance/Allowances) Given a workpiece, blueprint, and references; calculate tolerance/allowance for specific job to a bilateral tolerance of +/- .001 inches.

5. (Convert Common Fractions to Decimal Fractions) Given blueprint, convert fraction dimensions to decimal dimensions with an accuracy of +/- .001 inches.

6. (Convert Dimensions to Metric Sizes) Given blueprint and references, convert dimensions on blueprint to metric equivalents. Dimensions must be with in a tolerance of +/- 1/100th mm

1. Determine the rpm for a 3/8 inch drill that is to drill cast iron with a cutting speed of 80 feed per minute. Use the formula: $\text{rpm} = \frac{4 \times CS}{D}$ SHOW ALL WORK.

2. In a "three wire thread measuremnt", using the largest size wire, calculate the measurement over the wires for a 3/4 inch - 10 NC thread.

3. In a "three wire thread measurement", using the best size wire, calculate the measurement over the wires for a 5/8 inch - 18 NF thread.

4. For the following workpiece, calculate:
   a. taper per foot
   b. tailstock offset

   WORKPIECE
   Large Dia. = 2
   Small Dia. = 1 3/4
   Taper Len. = 4
   Overall Len. = 10

5. What rpm is required to rough turn a workpiece of 13 inch diameter machine steel?

6. At what rpm should a 1 inch piece of machine steel be revolved for:
   a. threading
   b. knurling

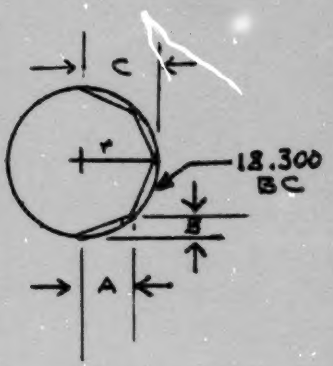
7. How much allowance should be left when reaming a hole with a 5/16 inch diameter?

8. Calculate the tap drill size for cutting an internal thread of 1 1/2 inch - 6 NC on a lathe.

9. To grind an angular surface, calculate the gage block build-up for the angle of 18 degrees using a 5" sine bar.

10. a. If the circle to the right has a 3/8 inch radius, what is the diameter?

    b. Using information provided by the insructor, calculate the values for a,b,and c.



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APPENDIX F	PREVIOUS ARTICULATION INFORMATION, IF ANY
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APPENDIX A

THE SCHOOL DISTRICT
OF GREENVILLE COUNTY

GREENVILLE TECHNICAL COLLEGE

TO: All Administrators, Staffs and Faculties, The School District of Greenville County and Greenville Technical Collage

SUBJECT: Application and Implementation of the Policies and Procedures for the Articulation of Similar Vocational Training Programs of Instruction

Since 1976, The School District of Greenville County and Greenville Technical College have been working toward making the articulation of vocational education programs a viable and valid reality. Through joint efforts in the Occupational Education Articulation Program, The School District of Greenville County and Greenville Technical College fully support the concept of articulation and agree upon the purposes of the articulation program.

This Policies and Procedures Guide has been developed as a joint effort of The School District of Greenville County and Greenville Technical College with the assistance of individuals representing the institutional administrative units, involved faculty, and the local business and industrial community. The Policies and Procedures Guide is designed to assist the articulation of very similar programs of vocational training between the secondary and post-secondary, public, vocational training institutions in Greenville County.

Appreciation is expressed to participants at both institutions for the joint effort of this endeavor.

J. F. Hall
J. F. Hall
Superintendent
The School District of
Greenville County

Thomas E. Barton
Thomas E. Barton
President
Greenville Technical College

TASK FORCE COMMITTEE
AGREEMENT TO ARTICULATE
VOCATIONAL EDUCATION

Articulation provides a system whereby secondary and post-secondary instructors can cooperate effectively in providing a continuous occupational development program where the level and type of vocational training that leads to entry-level employment skills will be clear to instructors, other educators, students, and potential employers.

The concept of articulation and the articulation program are supported fully be The School District of Greenville County and Greenville Technical College which have agreed upon a statement of purpose for the articulation of similar vocational education programs in Greenville County.

The articulation program in Greenville County is a joint effort of The School District of Greenville County and Greenville Technical College to develop a continuous program of vocational training so that students may continue their career preparation without loss of time or waste of effort in repeating tasks which have been learned previously and demonstrated. Articulation program activities are designed to help remove unnecessary gaps or overlap in student learning which may occur when a student completes a secondary vocational program and continues career development at the post-secondary level in a similar occupational field.

To implement articulation, instructor representatives from the participating institutions have met as a task force committee to develop this articulated, performance-based instruction guide which describes the secondary vocational program and which provides the parameters for vertical articulation.

Vertical articulation shall include recognition of the occupational competencies demonstrated by secondary graduates of articulated vocational programs.

It is agreed that...

The task force committee instructor representatives from The School District of Greenville County and Greenville Technical College mutually recognize the value of occupational education provided by each institution.

The task force committee instructor representatives will take the necessary actions, approved by their administrations, to ensure that this agreement to articulate is fulfilled including interpreting the program to students.

It is understood that periodic review of the articulated task objectives, performance actions, minimum standards, and outcome-referenced measures will be necessary to ensure that a valid training program is serving the needs of the community and the students.

Each task force committee participant hereby agrees to notify the others of any changes which modify the articulated, performance-based vocational program described in this guide so that each articulation guide, and where appropriate the articulation program, may be revised mutually so that articulated occupational training in Greenville County will conform to the minimum standards outlined in this guide.

This agreement to articulate establishes the necessary framework for lateral as well as vertical articulation.

AGREED UPON BY THE TASK FORCE COMMITTEE PARTICIPANTS ON THIS DAY,

April 30, 1984.
date

Name	Institution/School
Joseph George Caldwell	Foothills Career Center
Melvin Nestich	Donaldson Career Center
Randy McWhorter	Enoree Career Center
Charles Granger	Greenville Technical College

PHILOSOPHY OF ARTICULATED, PERFORMANCE-BASED INSTRUCTION GUIDE DESIGN

The design of the articulated, performance-based instruction guides and the articulation program is based on a philosophy that the vocational education curriculum should be for career training with few fringe or non-related subjects. The student should be given the basis to do useful skilled work upon graduation and employment. The vocational program graduate should have a background which will allow him/her to learn and advance as rapidly as possible on the job, but it should not include subject matter which will not be applicable to his/her work for years. When subject matter is introduced that will not be applicable to the graduate's work for years, it may put the graduate out of perspective. The result might be that the graduate may try to force applications which do not exist, simply because the information is in his/her repertoire. Thus, the purpose of vocational training by the articulated, performance-based instruction guides is to prepare graduates for successful entry into a skilled trade.

To ensure that the design of the articulated, performance-based instruction guides is conforming to the philosophies of both the secondary and post-secondary institutional participants, a periodic review of the guide design and philosophy is recommended.

PURPOSES OF THE ARTICULATED INSTRUCTION GUIDE

The articulated instruction objectives guide are is expected to serve the following purposes:

1. The guide serves as the primary vehicle for the articulation of subject matter in similar vocational training programs between the vocational education centers, high schools, and Greenville Technical College through use by instructors at both levels as a reference in preparing instruction.

2. The guide provides a listing of the minimum tasks that a student or worker is expected to perform in the conduct of a specific level job in the area of vocational training or work of concern.

3. The guides identify the primary detailed instruction objectives, performance objectives which are based upon the task listings. The tasks are listed in the sequence of complexity, with the least complex task being listed first, except where a task must be performed as a prerequisite to performance of another task.

4. The guides identify the tasks performed (actions, steps, sets of skills) and related technical information which must be taught and learned to accomplish each major instruction objective. The tasks performed represent the minimum skills and related information required for adequate occupational proficiency in the performance objectives.

5. The guides designate the instructional contact hours necessary to provide the required instruction, as required by appropriate educational agencies or offices and as estimated by the instructor-participants on the Vocational Articulation Project Task Forces, and based on the time required to teach the average learner to perform the task. The time estimated is based on having the essential equipment, facilities and instructional aids required to provide the instruction, whenever the class size is limited to an acceptable number.

6. The guides identify the performance standards to be met for occupational proficiency in the task. Performance standards used are those considered to be minimum business or industry standards. The ability to meet the listed standards of performance will be considered as qualification for advanced instruction in the vocational program.

7. The guides provide direction in the conduct of sequential vocational competency instruction by modules or job tasks, resulting in qualification by the learner to perform limited skill specialist jobs of

progressively higher skills until the program objective is reached (i.e., file clerk to executive secretary, etc.). As the student becomes proficient in the performance of tasks in successively more complex modules, more marketable competencies are gained and may be identified as the lower job qualifications of a specialist.

Through this procedure, even the slower student is provided an opportunity to eventually gain sufficient skills to perform adequately as a specialist at some level in the vocational field, even if the student is unable to complete the total program of training.

The standardized sequence of activities of the vocational instruction modules will facilitate lateral articulation between vocational education centers in the School District and will simplify vertical articulation when training is continued at Greenville Technical College articulating to employers.

8. The guides provide a descriptive listing of equipment required to conduct the program of vocational training. The equipment listed is considered to be the type and quantity essential for the conduct of instruction to prepare students for entry-level employment in the vocational field. It may be necessary to delay teaching some tasks involving special equipment, if that equipment is not available at all instructional sites, or to move students and equipment together as necessary to teach skills.

9. The guide provides information about requirements or limitations that typically are involved in the performance of the task, environmental conditions and physical demands, and able to perform the task.

10. The guides provide a list of standardized performance test items/ and outcome-referenced measures to be used in the determination of vocational proficiency. As long as the specifics are not provided, the test items listed cannot be compromised easily and could serve as study guides.

11. The tasks listed in the guide are the minimum requirements for job qualification under average circumstances in a regional market. It is understood that there may be unlisted tasks that some employers may require the worker to do in the occupation, when in their employment. In addition, there may be unlisted tasks, such as mental process tasks, that are not stated but that may occur and that should be considered in instructional planning or testing.

Instructors may teach skills and related technical information other than what is shown in the guides. Provision of additional information should be limited to the students who have completed the requirements for the tasks emphasized in the instructional guides. The change of tasks in the guides should be based on task force committee agreement to ensure lateral and vertical articulation.

12. It is expected that there will be updating and correction of items in the articulated instruction guide. Participants are to be sure that the contents are valid and consistent with business and industry requirements. Recommendations should be submitted to the Vocational Articulation Program office which will assemble and present them to the appropriate committee for review and possible adoption.

13. Typically, the teacher/instructor should not plan to conduct instruction in a given articulated module unless the capability exists to conduct all of the instruction to meet the instructional objectives, with the result that the successful student is qualified to perform the tasks identified within the module.

14. An underlying philosophy in vocational training is that it is better to prepare the student to be fully qualified to perform all of the tasks in a limited group of modules in a vocational field and be qualified at a lower job level rather than to be only familiar with a large number of task descriptions or duties and qualified to perform none of them fully. For higher levels of job qualification beyond the secondary level, the student or worker is encouraged to enroll at Greenville Technical College.

15. Generally, vocational programs will include certain basic modules or courses of instruction without which the student would not be considered vocationally qualified at any level. Basic modules typically will be identified and taught early in the program sequence.

16. The instruction guides provides information essential to help the vocational student who completes training at the secondary level and continues career development training at the post-secondary level in a similar program receive appropriate credit for the articulated vocational training that has been mastered at the secondary level.

DEFINITIONS OF TERMS

The following definitions of terms are applicable to the articulated, performance-based instruction guides developed as products of the Occupational Education Articulation Program.

Behavior:	The actions of a person (specifically, job or job training actions). Behavioral actions include both overt, those that can be observed, and covert, those not observable outwardly. Performance may be interchanged with behavior in the project. (See also Performance Actions).
Concept:	A group of ideas that may be classed together or that are similar.
Criteria:	A standard by which performance may be measured, usually considered the minimum standard.
Domain:	A cluster of related jobs.
Duty:	One of the distinct major activities involved in the work performed and comprising related tasks.
Evaluation:	When comparison is made between a measurement and a standard and judgment is passed on the comparison.
Item:	A single stimulus or stimulus pattern that calls for a single response or set of responses. It is one sample of behavior or performance. The response may be simple or complex.
Job:	The duties or tasks actually performed by a specified individual.
Knowledge:	In this project, knowledge refers to acquired covert behavior which facilitates skills and performance, such as the theoretical information of what should be done under given circumstances, and in what order of sequence performance should occur to accomplish the objective.
Measurement:	The process of determining the extent some characteristic is associated with the student.
Module:	Modules in the pilot Drafting and Business and Office Education curriculum modifications in the Occuptional Education Articulation Program have been designed to

coincide secondary level training with post-secondary level similar areas of training.

Another method of developing modules might be for modules to represent an identifiable, complicated task or job area involving a number of sub-tasks such as "Electrical Systems" in Automotive Mechanics.

Norm-referenced Evaluation: In norm-referenced evaluation, measures are dependent on a relative standard. Measures compare the capabilities of one student to those of other students.

Objective: (See Performance Objective) A stated desired outcome of training or the end result of the job, task, or performance actions. Objectives referred to in this project will be terminal objectives, generally representing a specific job function.

Occupational Education: An organized sequence of learning experiences consisting of vocational theory, practice, and skills taught to students on a regular or systematic basis.*

*Reference: Standards of the Delegate Assembly (Atlanta: Southern Association of Colleges and Schools, Commission on Occupational Education, December, 1972) p. 12.

Outcome-referenced Evaluation: Outcome-referenced, or criterion-referenced, measurement provides a standard of achievement for the individual as compared with specific behavioral objectives and therefore provides information about the degree of competence attained by the student.

The outcome-referenced measure is a performance or other measure based upon a performance objective, the accomplishment of which measures attainment of that objective.

Performance: Performance is used in this project to refer to a job or task which results from a set of sequential actions or steps.

Performance Actions: A series of steps, generally arranged in a sequence ordinarily followed, which when completed may result in the accomplishment of a performance objective (performance of a task).

Performance actions may be referred to as a set or sets of skills, functions, or steps. V-TEC (Vocational-Technical Education Consortium of States) catalogs generally describe performance actions in the "performance guide" of their format.

Articulated, Performance-based Instruction Guide: A comprehensive collection of performance objectives, performance actions to obtain those objectives, suggested hours for instruction (for planning purposes), performance standards, related technical information, and outcome-referenced measures, as well as general secondary level and post-secondary level descriptions of similar courses for the purposes of aiding lateral and vertical articulation concerning the subject area.

Performance-based Instruction: Performance-based (competence-based) instruction is based on the competencies or tasks performed by on-the-job workers. Everything in a performance-based instruction system is made public beforehand. There are no surprises for student, teacher, counselor, or employer. When the student begins a program, information is available to tell the student exactly what competencies are expected to be developed as a result of the instructional program, how and against what standards or criteria the student will be evaluated, and how the student's competencies will be communicated to the student, instructors, and to employers. A performance-based instructional system tells the student exactly what the student must learn, teaches the student that skill or knowledge, and then tests on mastery of that specific competence.

Performance Objective: A statement in precise, measurable terms of a particular behavior to be exhibited by a learner under specified conditions. It possesses each of the elements or characteristics specified below:

Conditions under which the performance is to take place.

Behavior Desired or expected of the student (things to be done, the performance desired).

Standards to determine how well the performance is to be done (criteria).

Performance Test: A performance test requires the student to demonstrate (master) the desired behavior of the objective (accomplish a job-like task) under controlled conditions and according to predetermined standards. The controlled conditions allow the student to demonstrate the desired behavior and the conditions remain consistent from student to student.

Skill: Primarily, skill refers to overt, observable performance, however, it is recognized that there are covert skills required in some performances.

Step: Step is used to refer to a task or action, generally as a sequence of steps involved in the accomplishment of a performance objective or job.

Systems Approach: The systems approach to instruction emphasizes the specification of instructional objectives, precisely controlled learning experiences to achieve the objectives, criteria for performance, and evaluative information.

Task:	A task is a set of skills (set or sets of functions, actions, or steps) the student must perform to accomplish the job (training). A task may be described as a logically related set of actions necessary or required to complete the job objective. Several tasks could be referred to as a duty.
Task Analysis:	Task analysis is breaking down a learning task (objective) into component tasks each of which must be mastered as a prerequisite to mastery of the total job.
Task List:	A listing of tasks (performance objectives) performed by incumbent workers (students in training) within a domain of interest (course of study).
Test:	An event during which the student is asked to demonstrate some aspect of knowledge or skill is a test. It can be a single test item, but usually it consists of several items.

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APPENDIX F

MACHINE TOOL TECHNOLOGY ARTICULATION

Greenville Technical College GREENVILLE, SOUTH CAROLINA · 29606

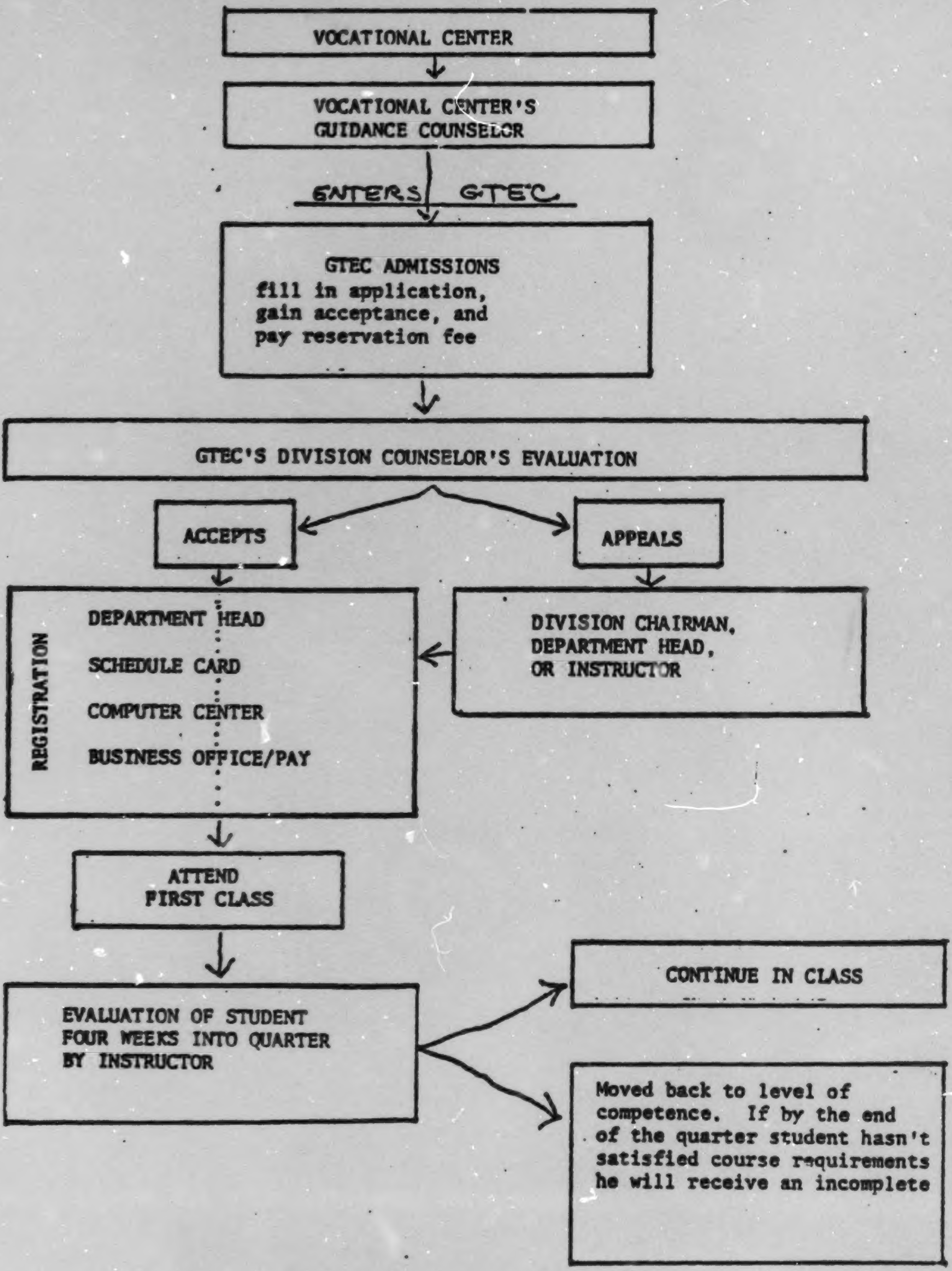
OVERVIEW

Evaluation for articulation into the Machine Tool Technology program at Greenville Technical College begins with the vocational student at his/her vocational center. The student should properly complete a release form in order to allow his/her "machine shop transcript" to be sent to the Industrial Division counselor at GTEC. This "transcript" should have been completed by the machine shop instructor at the center.

The GTEC guidance counselor will evaluate the "transcript" by the Machine Shop Transcript Evaluation Form. This form has a list of Career Cluster Project objectives that have been correlated to the machine shop courses at GTEC. Completion of objectives listed by each project within the four quarters of courses will be considered completion of that project at GTEC. A recommendation is made by the counselor for placement in the Machine Tool Technology program.

If the student disagrees with the counselor's recommendation and requests a higher placement, there is a detailed procedure for reviewing the evaluation by members of the Machine Tool Technology department. (See "Articulation Evaluation Procedure" in this booklet.) If the student requests a lower placement, his/her request will be honored at this time.

ARTICULATING MACHINE SHOP STUDENT FLOW CHART


VOCATIONAL CENTER
VOCATIONAL CENTER'S GUIDANCE COUNSELOR
ENTERS GTEC
GTEC ADMISSIONS
fill in application, gain acceptance, and pay reservation fee
GTEC'S DIVISION COUNSELOR'S EVALUATION
ACCEPTS
APPEALS
REGISTRATION
DEPARTMENT HEAD
SCHEDULE CARD
COMPUTER CENTER
BUSINESS OFFICE/PAY
DIVISION CHAIRMAN, DEPARTMENT HEAD, OR INSTRUCTOR
ATTEND FIRST CLASS
EVALUATION OF STUDENT FOUR WEEKS INTO QUARTER BY INSTRUCTOR
CONTINUE IN CLASS
Moved back to level of competence. If by the end of the quarter student hasn't satisfied course requirements he will receive an incomplete

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The project presented or reported herein was performed pursuant to a Grant from the U. S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education and no official endorsement by the U. S. Office of Education should be inferred.

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MACHINE TOOL TECHNOLOGY

ARTICULATION GRANT

GREENVILLE TECHNICAL COLLEGE

JUNE, 1976

ARTICULATION EVALUATION PROCEDURE

I. Entering Student Is Evaluated by GTEC Division Guidance Counselor with students signature for release

1. Yellow Card (MTT transcript)

II. Student Accepts- - or -

1. Registers for suggested quarter

II. Student Appeals -

1. Division Chairman, Department Head or Instructor will reevaluate student.
2. Deficiencies listed and closer evaluation given - decision reissued with counseling on its rational
   a. appeal denied - go to #3
   b. appeal accepted - go to #4
3. If appeal denied, student allowed to register for suggested MTT course
4. If appeal accepted, time expectancies on student's performance and quality determined and noted to him
5. At the end of 4 weeks the student must meet with the instructor involved to justify continuance based on performance of heretofore listed deficiencies and appropriate progress into the quarter's work
   a. If student's work acceptable, he continues through the quarter.
   b. If not acceptable, student will be moved back to his level of competency. If by the end of the quarter student hasn't satisfied course requirements, he will receive an incomplete.

III. Evaluation of Student, four weeks into quarter, by instructor to verify acceptable level of performance and appropriate initial evaluation

The evaluation instrument development by the South Carolina State Department of Education for the Cluster Project in the ARC funded program for Machine Shop has been included under Machine Tool Technology by courtesy of the South Carolina State Department of Education.

AGE ____________ PHONE ____________ SS ______

HIGH SCHOOL

____

RELEASE DATE

CONDITION OF RELEASE:

Completed course [ ] Dropped course [ ] Moved [ ] Other ____________

____

TO BE COMPLETED ONLY BY THE RELEASING INSTRUCTOR

IMPORTANT: BECAUSE THIS RECORD WILL BE REVIEWED BY OTHER INSTRUCTORS IN VOCATIONAL HIGH SCHOOLS, AVC'S, AND TEC CENTERS AS A PRELUDE TO ALLOWING THIS STUDENT CREDIT TOWARDS THE COURSE IN THESE INSTITUTIONS, IT IS IMPERATIVE THAT THIS FORM BE FILLED OUT COMPLETELY. OMIT NO ITEMS. IF THE INFORMATION REQUESTED IS UNKNOWN, SO INDICATE.

COMMENTS:

EVALUATION OF STUDENT BY RELEASING INSTRUCTOR

CIRCLE THE MOST APPROPRIATE RESPONSE (IN YOUR JUDGEMENT) USING THE SCALES PROVIDED. OMIT NO ITEMS. WRITE "UNKNOWN" TO THE SIDE OF THE ITEM IF NECESSARY. BE SURE TO INDICATE THE CLASS SIZE ON THE LAST ITEM.

KNOWLEDGE AND USE OF SAFETY RULES.	Excellent	Good	Acceptable	Poor	Unacceptable
KNOWLEDGE AND USE OF TOOLS.	Excellent	Good	Acceptable	Poor	Unacceptable
ABILITY TO USE HANDS (MANUAL DEXTERITY).	Excellent	Good	Acceptable	Poor	Unacceptable
ABILITY TO ACCOMPLISH MULTIPLE PROBLEM DIAGNOSIS AND REPAIR. REPAIR.	Excellent	Good	Acceptable	Poor	Unacceptable
INTEREST IN THE MACHINIST FIELD.	Excellent	Good	Acceptable	Poor	Unacceptable
ABILITY TO FUNCTION ACADEMICALLY (READING AND MATH PROBLEM SOLVING) IN THE MACHINIST FIELD.	Excellent	Good	Acceptable	Poor	Unacceptable
ANTICIPATED CHANCES OF SUCCESS IF STUDENT TAKES A JOB IN THE MACHINIST FIELD.	Excellent	Good	Acceptable	Poor	
ANTICIPATED DEPTH OF ADDITIONAL TRAINING IN THE MACHINIST FIELD THE STUDENT WILL NEED TO BE SUCCESSFUL IN THE FIELD.	Much More	More	Little More	None	
ABILITY OF STUDENT TO BENEFIT FROM FURTHER TRAINING IN THE MACHINIST FIELD.	Excellent	Good	Acceptable	Poor	Unacceptable
ABILITY OF STUDENT TO HANDLE THE PERFORMANCE OF TASKS AND PROCEDURES RELATING TO THE MACHINIST FIELD.	Excellent	Good	Acceptable	Poor	Unacceptable
ABILITY OF THE STUDENT TO CONCENTRATE OVER A PERIOD OF TIME.	Excellent	Good	Acceptable	Poor	Unacceptable
OVERALL RANKING OF STUDENT AS COMPARED WITH OTHER STUDENTS IN THE SAME COURSE.	Upper 5%	Upper 10%	Upper 25%	Upper 50%	Lower 50%

OF A CLASS OF_____ STUDENTS.

PERMISSION TO RELEASE THIS RECORD TO OTHER SCHOOLS AND/OR PROSPECTIVE EMPLOYERS FOR THEIR USE IN MY BEHALF IS HEREBY GRANTED.

DATE:______________

SIGNATURE OF STUDENT: ______________________________

SIGNATURE OF PARENT OR GUARDIAN IF STUDENT IS LESS THAN 18 YEARS OLD:

____

TOTAL TEST SCORES

MSCT:________ DATE:____________

MSCT:________ DATE:____________

MSPT:________ DATE:____________

MSPT:________ DATE:____________

UNITS OR SECTIONS COMPLETED BY STUDENT

NOTE: PLACE A CHECK IN THE BLOCKS BESIDE THE UNITS OR SECTIONS WHICH WERE AT LEAST 90% COMPLETED BY THE STUDENT. USE THE PROGRESS RECORD ON THE BACK OF THIS FORM TO DETERMINE COMPLETED UNITS. THE UNITS OR SECTIONS CHECKED HERE MUST AGREE WITH THE PROGRESS RECORD ON THE BACK OF THIS FORM.

- 1. SHOP MATH ☐
- 2. BLUEPRINT READING ☐
- 3. MEASURING ☐
- 4. LAYOUT ☐
- 5. BENCH WORK ☐
- 6. BENCH-PED. GRINDING ☐
- 7. DRILL PRESS ☐
- 8. DRILL GRINDING ☐
- 9. POWER SAWS ☐
- 10. ENGINE LATHE ☐
- 11. MILLING MACH. INTRO. ☐
- 12A. MILLING MACH. VERT. ☐
- 12B. MILLING MACH. HOR. ☐
- 13. SHAPER ☐
- 13A. PLANER ☐
- 14. SURFACE GRINDING ☐
- 15. TOOL POST GRINDING ☐
- 16. UNIVERSAL GRINDING ☐
- 17. METALS - HEAT TRT. ☐
- 18. JIG BORING ☐
- 19. OXYACET. WELDING ☐
- 20. ARC WELDING ☐
- 21. BASIC DESIGN. ☐
- 22A. ENGR. APPR. ☐
- 22B. DRILL JIG COMPONTS. ☐
- 22C. DRILL JIG DSGN. ☐
- 22D. MILL. FIXT. COMPONTS. ☐
- 22E. MILL. FXT. DSGN. ☐

RECORD OF GRADES FOR THIS COURSE

GRADING PERIOD						GRADE	INSTRUCTOR
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________
PERIOD:	(SEM)	(QTR)	(9 WKS)	OTHER	________	____	__________

Signature of Releasing Instructor: ______________________________

Date:

____

SDE 26-051-00
(This form becomes obsolete 6/30/80)

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BEST COPY AVAILABLE

1- 1 ☐ ___ DATE: __________
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BLUEPRINT READING

2- 1 ☐ ___ DATE: __________
2- 2 ☐ ___ DATE: __________
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2- 6 ☐ ___ DATE: __________
2- 7 ☐ ___ DATE: __________

MEASURING

3- 1 ☐ ___ DATE: __________
3- 2 ☐ ___ DATE: __________
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3-23 ☐ ___ DATE: __________
3-24 ☐ ___ DATE: __________
3-25 ☐ ___ DATE: __________
3-26 ☐ ___ DATE: __________

LAYOUT

4- 1 ☐ ___ DATE: __________
4- 2 ☐ ___ DATE: __________
4- 3 ☐ ___ DATE: __________
4- 4 ☐ ___ DATE: __________
4- 5 ☐ ___ DATE: __________
4- 6 ☐ ___ DATE: __________
4- 7 ☐ ___ DATE: __________

BENCH WORK

5- 1 ☐ ___ DATE: __________
5- 2 ☐ ___ DATE: __________
5- 3 ☐ ___ DATE: __________
5- 4 ☐ ___ DATE: __________
5- 5 ☐ ___ DATE: __________
5- 6 ☐ ___ DATE: __________
5- 7 ☐ ___ DATE: __________

6- 1 ☐ ___ DATE: __________
6- 2 ☐ ___ DATE: __________
6- 3 ☐ ___ DATE: __________

DRILL PRESS

7- 1 ☐ ___ DATE: __________
7- 2 ☐ ___ DATE: __________
7- 3 ☐ ___ DATE: __________
7- 4 ☐ ___ DATE: __________
7- 5 ☐ ___ DATE: __________
7- 6 ☐ ___ DATE: __________
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7- 8 ☐ ___ DATE: __________
7- 9 ☐ ___ DATE: __________
7-10 ☐ ___ DATE: __________
7-11 ☐ ___ DATE: __________
7-12 ☐ ___ DATE: __________
7-13 ☐ ___ DATE: __________
7-14 ☐ ___ DATE: __________

DRILL GRINDING

8- 1 ☐ ___ DATE: __________
8- 2 ☐ ___ DATE: __________

POWER SAWS

9- 1 ☐ ___ DATE: __________
9- 2 ☐ ___ DATE: __________
9- 3 ☐ ___ DATE: __________
9- 4 ☐ ___ DATE: __________
9- 5 ☐ ___ DATE: __________
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9-10 ☐ ___ DATE: __________
9-11 ☐ ___ DATE: __________
9-12 ☐ ___ DATE: __________
9-13 ☐ ___ DATE: __________

ENGINE LATHE

10- 1 ☐ ___ DATE: __________
10- 2 ☐ ___ DATE: __________
10- 3 ☐ ___ DATE: __________
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10-10 ☐ ___ DATE: __________
10-11 ☐ ___ DATE: __________
10-12 ☐ ___ DATE: __________
10-13 ☐ ___ DATE: __________
10-14 ☐ ___ DATE: __________
10-15 ☐ ___ DATE: __________
10-16 ☐ ___ DATE: __________
10-17 ☐ ___ DATE: __________
10-17A ☐ ___ DATE: __________
10-18 ☐ ___ DATE: __________
10-19 ☐ ___ DATE: __________
10-20 ☐ ___ DATE: __________
10-21 ☐ ___ DATE: __________
10-22 ☐ ___ DATE: __________
10-23 ☐ ___ DATE: __________
10-24 ☐ ___ DATE: __________
10-25 ☐ ___ DATE: __________
10-26 ☐ ___ DATE: __________
10-27 ☐ ___ DATE: __________

11- 1 ☐ ___ DATE: __________
11- 2 ☐ ___ DATE: __________
11- 3 ☐ ___ DATE: __________
11- 4 ☐ ___ DATE: __________
11- 5 ☐ ___ DATE: __________
11- 6 ☐ ___ DATE: __________
11- 7 ☐ ___ DATE: __________
11- 8 ☐ ___ DATE: __________
11- 9 ☐ ___ DATE: __________
11-10 ☐ ___ DATE: __________
11-11 ☐ ___ DATE: __________
11-12 ☐ ___ DATE: __________

VERT. MILLING MACH.

12-A- 1 ☐ ___ DATE: __________
12-A- 2 ☐ ___ DATE: __________
12-A- 3 ☐ ___ DATE: __________
12-A- 4 ☐ ___ DATE: __________
12-A- 5 ☐ ___ DATE: __________
12-A- 6 ☐ ___ DATE: __________
12-A- 7 ☐ ___ DATE: __________
12-A- 8 ☐ ___ DATE: __________
12-A- 9 ☐ ___ DATE: __________
12-A-10 ☐ ___ DATE: __________

HRZ. MILLING MACH.

12-B- 1 ☐ ___ DATE: __________
12-B- 2 ☐ ___ DATE: __________
12-B- 3 ☐ ___ DATE: __________
12-B- 4 ☐ ___ DATE: __________
12-B- 5 ☐ ___ DATE: __________
12-B- 6 ☐ ___ DATE: __________
12-B- 7 ☐ ___ DATE: __________
12-B- 8 ☐ ___ DATE: __________

SHAPER

13- 1 ☐ ___ DATE: __________
13- 2 ☐ ___ DATE: __________
13- 3 ☐ ___ DATE: __________
13- 4 ☐ ___ DATE: __________
13- 5 ☐ ___ DATE: __________
13- 6 ☐ ___ DATE: __________
13- 7 ☐ ___ DATE: __________

PLANER

13-A- 1 ☐ ___ DATE: __________

SURFACE GRINDING

14- 1 ☐ ___ DATE: __________
14- 2 ☐ ___ DATE: __________
14- 3 ☐ ___ DATE: __________
14- 4 ☐ ___ DATE: __________
14- 5 ☐ ___ DATE: __________
14- 6 ☐ ___ DATE: __________

TOOLPOST GRINDING

15- 1 ☐ ___ DATE: __________
15- 2 ☐ ___ DATE: __________
15- 3 ☐ ___ DATE: __________
15- 4 ☐ ___ DATE: __________

UNIVRSL. GRINDING

16- 1 ☐ ___ DATE: __________
16- 2 ☐ ___ DATE: __________
16- 3 ☐ ___ DATE: __________

17- 1 ☐ ___ DATE: __________
17- 2 ☐ ___ DATE: __________
17- 3 ☐ ___ DATE: __________
17- 4 ☐ ___ DATE: __________
17- 5 ☐ ___ DATE: __________
17- 6 ☐ ___ DATE: __________
17- 7 ☐ ___ DATE: __________
17- 8 ☐ ___ DATE: __________
17- 9 ☐ ___ DATE: __________
17-10 ☐ ___ DATE: __________
17-11 ☐ ___ DATE: __________
17-12 ☐ ___ DATE: __________
17-13 ☐ ___ DATE: __________
17-14 ☐ ___ DATE: __________
17-15 ☐ ___ DATE: __________

JIG BORING

18- 1 ☐ ___ DATE: __________
18- 2 ☐ ___ DATE: __________
18- 3 ☐ ___ DATE: __________
18- 4 ☐ ___ DATE: __________
18- 5 ☐ ___ DATE: __________
18- 6 ☐ ___ DATE: __________
18- 7 ☐ ___ DATE: __________
18- 8 ☐ ___ DATE: __________
18- 9 ☐ ___ DATE: __________
18-10 ☐ ___ DATE: __________

OXYAC. WELDING

19- 1 ☐ ___ DATE: __________
19- 2 ☐ ___ DATE: __________
19- 3 ☐ ___ DATE: __________
19- 4 ☐ ___ DATE: __________
19- 5 ☐ ___ DATE: __________
19- 6 ☐ ___ DATE: __________
19- 7 ☐ ___ DATE: __________
19- 8 ☐ ___ DATE: __________
19- 9 ☐ ___ DATE: __________
19-10 ☐ ___ DATE: __________

ARC WELDING

20- 1 ☐ ___ DATE: __________
20- 2 ☐ ___ DATE: __________

BASIC DIE MKNG.

21- 1 ☐ ___ DATE: __________
21- 2 ☐ ___ DATE: __________
21- 3 ☐ ___ DATE: __________
21- 4 ☐ ___ DATE: __________
21- 5 ☐ ___ DATE: __________
21- 6 ☐ ___ DATE: __________
21- 7 ☐ ___ DATE: __________
21- 8 ☐ ___ DATE: __________
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21-10 ☐ ___ DATE: __________
21-11 ☐ ___ DATE: __________
21-12 ☐ ___ DATE: __________
21-13 ☐ ___ DATE: __________
21-14 ☐ ___ DATE: __________
21-15 ☐ ___ DATE: __________
21-16 ☐ ___ DATE: __________
21-17 ☐ ___ DATE: __________
21-18 ☐ ___ DATE: __________
21-19 ☐ ___ DATE: __________
21-20 ☐ ___ DATE: __________
21-21 ☐ ___ DATE: __________

22-A- 1 ☐ ___ DATE: __________
22-A- 2 ☐ ___ DATE: __________
22-A- 3 ☐ ___ DATE: __________

DRILL JIG COMPNTS.

22-B- 1 ☐ ___ DATE: __________
22-B- 2 ☐ ___ DATE: __________
22-B- 3 ☐ ___ DATE: __________
22-B- 4 ☐ ___ DATE: __________

DRILL JIG DSGN.

22-C- 1 ☐ ___ DATE: __________
22-C- 2 ☐ ___ DATE: __________
22-C- 3 ☐ ___ DATE: __________
22-C- 4 ☐ ___ DATE: __________

MILL. FIXT. COMPNTS.

22-D- 1 ☐ ___ DATE: __________
22-D- 2 ☐ ___ DATE: __________
22-D- 3 ☐ ___ DATE: __________

MILL. FIXT. DSGN.

22-E- 1 ☐ ___ DATE: __________
22-E- 2 ☐ ___ DATE: __________
22-E- 3 ☐ ___ DATE: __________
22-E- 4 ☐ ___ DATE: __________

OFFICIAL STUDENT PROGRESS RECORD
for
Machine Shop

NOTICE TO INSTRUCTOR(s): This is an OFFICIAL record of the student's progress in the course. Please follow these directions EXACTLY:

1. Draw a line through all LAPs which you do not require of the student to get credit for the unit.

2. Place a check in the block beside each required LAP when:

    a. You have PASSED the student on the LAP, or

    b. You are giving the student CREDIT for the LAP because of YOUR PERSONAL KNOWLEDGE that the student has competence in the training required by the LAP.

3. Optional: Space is provided for your initials and the date.

4. Be sure to complete ALL other relevant information about the student on this form.

5. If the student completes the course or withdraws from the course for ANY reason, complete the reverse side of this form and IMMEDIATELY forward to the records office.

Instructor's signature:

____

SDE 26-051-00
(This form becomes obsolete 6/30/80)

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AV-AV used, not necessarily objective

( ) - objective but not necessarily AV used

I - Introduced at this point, proficiency expected next quarter

* - increased expectation tolerance with usage

I* - Introduced in specific units, expected proficiency by end of quarter

+ - performance evaluated

✓ - "pencil & paper" evaluated

+, I - tolerance initially less than stated objective

Complete information on back of form before beginning evaluation.

MACHINE SHOP TRANSCRIPT EVALUATION FORM

Name of student being evaluated

Vocational center attended

Date of graduation / Date of evaluation

Name of evaluator

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MACHINE SHOP TRANSCRIPT EVALUATION FORM

Name ____________________

Introduction

____5-1.
____5-3.
____5-4.
____(5-7)+
____7-1.
____(10-5).
____(10-26)+
____11-1.
____(11-2)
____(11-3).
____(11-4)
____11-5.
____12A-2).
____(12A-4)-
____(12A-7).

End of First Quarter

____(7-12).
____(7-13).
____(8-1-I)-
____(9-2).
____(9-3).
____(9-5)-

- 1st QUARTER -

Project 1-A

____3-1+
____3-8+
____3-10+
____9-1-AV.
____9-11+
____10-3-AV+
____10-4+
____10-6-I+
____10-12-I
____10-13+
____10-15-AV+
____10-23-I+

Project 1-B

____3-1+
____3-10-AV+
____3-16-AV+
____3-19-AV-I
____4-1+
____5-2-
____5-5+
____7-2+
____(7-3)-
____(7-4)+
____7-5+
____(7-6)-
____7-7+
____9-11-
____10-4-
____12A-10+
____14-1.
____14-2-I+
____14-3-I+
____14-4-I+

Project 2-A

____3-1+
____3-8+
____3-10-AV+
____3-13+
____3-19-I*+
____9-11+
____10-3+
____10-4+
____10-6-AV-I+
____10-8-AV-I+
____10-13-AV+
____10-15-AV+
____10-17+
____10-20-AV
____10-22-AV-I*+

Project 2-B

____3-1+
____3-7
____3-8+
____3-10+
____3-16+
____3-19-AV
____(3-20)+
____3-24+
____4-3+
____4-7-AV
____5-2+
____5-5-
____(7-4)+
____7-5+
____(7-9)+
____(7-10)+
____(7-11)+
____9-11+

Project 3-A

____3-1+
____3-8*
____3-17-I
____9-11+
____(10-14)+
____(10-15)+
____10-17+
____10-22-I*+
____11-6-I*+
____11-7-I*+
____11-9-I+
____12A-10

Project 3-B

____3-1-
____9-11-
____10-22-I*
____10-23-I+
____10-24
____10-25-L
____11-6-I*+
____11-7-I*+
____11-9-I+
____12A-10

Project 2-B Continued

____10-1.
____10-2.
____10-3+
____11-11-I+
____12A-3-AV+
____12A-4-AV+
____12A-10+
____14-2-I*
____14-3-I*
____14-4-I

- 2nd QUARTER

Project 4

____3-19+
____(8-1)+
____10-7-AV-I+
____10-8+
____10-9+
____10-10+
____10-12-AV+
____10-17+
____10-18+
____10-22+
____10-25.
____11-6+
____11-7+
____11-9+
____11-10+
____12A-10+
____12B-6-I+
____15-1+

Project 5

____3-10-AV-Rev. +
____3-12-AV-I+
____10-12+
____10-16+
____10-18+
____10-23+
____15-1+
____15-2+

- 3rd QUARTER

Project 6-A

____5-6+
____6-1+
____6-2+
____(7-4)+
____7-5+
____10-6+
____10-7+
____11-6+
____11-7+
____11-9
____12A-10+
____12B-6+

Project 6-B

____5-6+
____6-1+
____6-2+
____(7-4)+
____7-5+
____10-6+
____10-7+
____10-21-AV.
____11-9+
____11-11+
____12A-10+
____14-2+
____14-3+
____14-4+

- 4th QUARTER

Project 10

____3-12+
____10-22+
____12A-10+
____(13-1).
____(13-2).
____(13-3).
____13-4+
____(13-5)+
____(13-7)+
____14-2+
____14-3+
____14-4+

AV-AV used, not necessarily objective

( ) - objective but not necessarily AV used

I - Introduced at this point, proficiency expected next quarter

* - increased expectation tolerance with usage

I* - Introduced in specific units, expected proficiency by end of quarter

+ - performance evaluated

. "pencil & paper" evaluated

+, I - tolerance initially less than stated objective

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TUITION SCHOLARSHIP

Greenville Technical College is proud to offer tuition scholarships in each of the Articulation Grant programs: Machine Tool Technology, Industrial Electricity, and Engineering Graphics Technology. These scholarships were suggested at an Articulation Grant Advisory Committee meeting and hardily approved by the Greenville Technical College administration. It is hoped their inception will stimulate interest in continuing quality education and training in these fields.

The Donaldson, Enoree, and Foothills Vocational Centers will each select their most outstanding and/or worthy student in their drafting, electricity, and machine shop programs. Wade Hampton High School will select a student from their electricity program. The three scholarship students from each center will receive one quarter of tuition free study at Greenville Technical College. After their first quarter, each student may receive an extension for another quarter based upon review and approval by his or her instructors and department head.

After the selection of the students by their instructors, the director or principal of each school should send a copy of all the names to the heads of the Industrial and Technical Divisions, Mr. J.D. Warren and Mr. Les Caraway. This is necessary to insure the tuition waiver be available when the student begins.

GUIDANCE INFORMATION FORM

This form was designed to supply feedback to guidance counselors, instructors, and administrators. It will be sent by the Greenville Technical College department involved to the vocational center each time there is a horizontal line of asterisks. The information on the form will supply data to evaluate our effectiveness and suggest continuation or change in our procedures.

+ +

IT IS EXTEMELY IMPORTANT THAT THE STUDENT OR HIS/HER PARENT IF THE STUDENT IS UNDER 18 SIGNS THE PERMISSION BLANK ON THE SIDE OF THE FORM. IT WOULD BE ILLEGAL TO DISEMINATE THIS INFORMATION FROM GREENVILLE TECHNICAL COLLEGE WITHOUT THE PROPER SIGNATURE.

MACHINE SHOP
ARTICULATION STUDENT'S PROGRESS

Your student, ______________________________, from ________________

Vocational Center has exempted through MTT________ (quarter ____) and

may (conditionally, unconditionally) enroll in MTT________(quarter___).

This placement was based on
- _____the "machine shop transcript" only
- _____the "machine shop transcript" and an interview requested by _______________ and conducted by _____________
- _____vocational instructor's recommendation

The student
- _____readily accepted placement
- _____requested a lower placement - outcome ____________________
- _____requested a higher placement - outcome ____________________

Date of evaluation ______________________________

* * *

The student at mid-term has been re-evaluated and is
- _____progressing satisfactorily
- _____moved back to level of competence (may be able to finish quarter's work, may have to take Inc.)

____
Student's signature

____
Instructor's signature

Date __________________

* * *

The student at the end of the first quarter of work
- _____successfully completed MTT_____(grade ____) on ______(date).
- _____received an incomplete
- _____dropped out before end of quarter

* * *

Student's status at the end of the first year of work-____________________

____

I GIVE MY PERMISSION FOR THE INFORMATION ON THIS SHEET TO BE RELEASED TO GREENVILLE COUNTY SCHOOL SYSTEM.

DATE__________ LEGAL SIGNATURE ______________________ SIGNATURE OF PARENT IF UNDER 18 ______________________

MACHINE SHOP UNITS

UNIT 1	MATH - MATH DEPT.
UNIT 2	BLUEPRINT READING - ENGINEERING GRAPHICS DEPT.
UNIT 3	MEASURING
UNIT 4	LAYOUT
UNIT 5	BENCH WORK
UNIT 6	BENCH/PEDISTAL GRINDING
UNIT 7	DRILL PRESS
UNIT 8	DRILL GRINDING
UNIT 9	POWER SAWS
UNIT 10	ENGINE LATHES
UNIT 11	MILLING MACHINES
UNIT 12A	VERTICAL MILLING
UNIT 12B	HORIZONTAL MILLING
UNIT 13	SHAPER
UNIT 14	SURFACE GRINDING
UNIT 15	TOOL POST GRINDING
UNIT 16	UNIVERSAL GRINDING

UNITS TO BE USED AT GREENVILLE TEC

1ST QUARTER AT GREENVILLE TEC

INTRODUCTION

MS-3-1
MS-3-7
MS-3-8
MS-3-10
MS-4-1
MS-5-1
MS-5-3
MS-7-1

PROJECT 1A

MS-9-1
MS-9-11
MS-10-3
MS-10-12
MS-10-23
MS-10-15
MS-10-6
MS-10-13
MS-3-8
MS-3-1
MS-3-10

PROJECT 1B

MS-9-11
MS-12A-10
MS-3-10
MS-3-16
MS-3-19
MS-12A-10
MS-3-16
MS-7-2
MS-7-7
MS-14-1
MS-14-2
MS-14-3
MS-14-4
MS-14-5

1ST QUARTER (Continued)

PROJECT 2A

- MS-10-1
- MS-10-2
- MS-10-3
- MS-10-4
- MS-10-6
- MS-10-8
- MS-10-13
- MS-10-15
- MS-10-20
- MS-10-22
- MS-3-13
- MS-3-8
- MS-3-10

PROJECT 2B

- MS-12A-10
- MS-3-16
- MS-3-19
- MS-3-18
- MS-3-24
- MS-3-8
- MS-3-7
- MS-7-5
- MS-4-7
- MS-12A-3
- MS-12A-4
- MS-12A-10 BORING
- MS-3-10

PROJECT 3A

- MS-11-6
- MS-11-7
- MS-11-9

INSTRUCTOR MAY SUGGEST REVIEW OF SLIDES AND TAPES AS NEEDED.

PROJECT 3B

- MS-10-22
- MS-10-23
- MS-10-24

INSTRUCTOR MAY SUGGEST REVIEW OF SLIDES AND TAPES AS NEEDED.

PROJECT 4 (2ND QUARTER)

- MS-10-25
- MS-10-12
- MS-11-10
- MS-10-11
- MS-10-18
- MS-10-22 (if needed)
- MS-12B-6
- MS-11-7
- MS-11-9

2ND QUARTER (Continued)

PROJECT 5A
MS-3-10 REVIEW
MS-3-12
MS-15-1 OPTION
MS-15-2 OPTION.

THIS PROJECT MUST BE ASSEMBLED.

PROJECT 6A (3RD QUARTER)
MS-10-7
MS-11-7 REVIEW
MS-11-9 REVIEW

ASSEMBLY.

PROJECT 6B
MS-10-21

NOTICE CLOSE TOLERANCE- GRINDING-HOLE CENTER-DISTANCE
SPACER LENGTH-ASSEMBLY

PROJECT 10 (4TH QUARTER)

STUDENT DRAWS HIS OWN PRINT- MAKES PARTS TO SPECIFICATION AND ASSEMBLES PARTS-SHOULD BE NO REVIEW AT THIS POINT.

MACHINE SHOP - UNIT 2 - BLUEPRINT READING

MS-2-1 INTRODUCTION TO BLUEPRINT READING

When you finish this learning package, you will be able to answer questions about blueprints and ablut the title block and notes on blueprints.

MS-2-2 ONE, TWO, AND THREE VIEW DRAWINGS

When you finish this learning package, you will be able to identify the different views of objects as shown by isometric drawings of the object.

MS-2-3 ALPHABET OF LINES

When you finish this learning package, you will be able to identify the different types of lines used in blueprints.

MS-2-4 SECTIONS

When you finish this learning package, you will be able to identify the following sections: full, half, offset, broken out, revolved, and removed.

MS-2-5 SCALE DRAWING

When you finish this learning package, you will be able to answer (basic) questions about (interpreting the) scale (of a) drawing.

MS-2-6 FINISH MARKS

When you finish this learning package, you will be able to identify and explain the finish marks on blueprints.

MS-2-7 FREEHAND SKETCHING

When you finish this learning package, you will be able t make freehand sketches of cylindrical, rectangular, and irregularly shaped work pieces.

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MACHINE SHOP - UNIT 3 - MEASURING

MS-3-1 THE MACHINIST'S SCALE

When you finish this learning package, you will be able to use the machinist's scale to measure the length and width of a piece of stock. Your measurements must be within ± 1/64 of an inch of specifications.

MS-3-2 CENTER HEAD OF THE COMBINATION SET

When you finish this learning package, you will be able to locate and mark the center on both ends of a round bar of any size from ½" to 6" using the center head of the combination set. Your marks must be within ± 1/32 of an inch of specifications.

MS-3-3 THE SQUARE HEAD OF THE COMBINATION SET

When you finish this learning package, you will be able to use the square head to scribe straight lines and angles to within ±1/32 of an inch of specification.

MS-3-4 DIVIDERS

When you finish this learning package, you will be able to use the machinist's scale and dividers to transfer the dimensions of a drawing to a workpiece. Your transferred measurements must be within ±1/64 of an inch of specifications.

MS-3-5 HERMAPHRODITE CALIPERS

When you have finished this learning package, you will be able to use the hermaphrodite caliper to: a-scribe parallel lines on a workpiece, and b-locate and mark the center of a round workpiece. Your work must be within ± 1/64 of an inch of specifications.

MS-3-6 OUTSIDE CALIPERS

When you finish this learning package, you will be able to use the outside caliper and the machinist's scale to measure the outside diameter of round workpieces to within ±1/64" of specifications.

MS-3-7 BEVEL PROTRACTOR

When you finish this learning package, you will be able to use the bevel protractor of the combination set to lay out, on a workpiece, the various angles called for on a set of specifications to within ±1/2°.

MS-3-8 OUTSIDE MICROMETER

When you finish this learning package, you will be able to use the outside micrometer to measure: the outside diameter of round stock, the thickness of flat stock, and the length of flat stock.

MS-3-9 INSIDE CALIPERS

When you finish this learning package, you will be able to use the inside calipers and the outside micrometer to measure the inside diameters of tubular stock to within ±.002" of specifications.

MS-3-10 TELESCOPING GAGE

When you finish this learning package, you will be able to use the telescoping gage and the outside micrometer to measure internal dimensions to within ±.001" of specifications

MS-3-11 INSIDE MICROMETER
When you finish this learning package, you will be able to assemble and use the inside micrometer to measure inside diameters of tubular stock to within ±.001" of specifications.

MS-3-12 DEPTH MICROMETER
When you finish this learning package, you will be able to assemble, adjust, and use the depth micrometer to measure the depth of holes and slots to within ±.001" of specifications.

MS-3-13 SCREW PITCH GAGE
When you finish this learning package, you will be able to use the screw pitch gage to measure the number of threads per inch on any given screw or bolt.

MS-3-13A SCREW THREAD MICROMETER
When you finish this learning package, you will be able to use the screw thread micrometer to measure the pitch diameter of screw threads to within ±.001" of specifications.

MS-3-14 VERNIER CALIPER
When you get finished with this learning package, you will be able to use the vernier caliper to measure the outside and inside diameters of round stock and the depths of holes and slots to within ±.001" of specifications.

MS-3-15 SURFACE GAGE
When you finish this learning package, you will be able to use the surface gage to measure and scribe lines on vertical surfaces to within ±.010" of specifications.

MS-3-16 VERNIER HEIGHT GAGE
When you finish this learning package, you will be able to use the vernier height gage to make comparison checks to within ±.001" of specifications.

MS-3-17 OPTICAL COMPARATORS
When you have finished this learning package, you will be able to answer questions about optical comparators and how they work.

MS-3-18 GAGE BLOCKS AND DIAL INDICATORS
When you finish this learning package, you will be able to use gage blocks to verify the accuracy of a dial indicator to within ±.0001".

MS-3-19 DIAL INDICATOR
When you finish this learning package, you will be able to use the dial indicator to check the concentricity (roundness) of round stock to within ±.001".

MS-3-20 DIAL INDICATOR - VISE ALIGNMENT
When you finish this learning package, you will be able to use the dial indicator to aling a vise on a milling machine to within ±.001" of specifications.

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MACHINE SHOP - UNIT 3 CONTINUED - MEASURING

MS-3-21 RADIUS GAGE

When you finish this learning package, you will be able to use a radius gage to measure convex and concave radii of parts.

MS-3-22 PLANER GAGE

When you finish this learning package, you will be able to adjust the planer gage to a given height.

MS-3-23 VERNIER BEVEL PROTRATOR

When you finish this learning package, you will be able to use the universal vernier bevel protractor to lay out a given angle, with an accuracy of ± 0°5'.

MS-3-24 SINE BAR

When you finish this learning package, you will be able to use a sine bar to measure and set up various angles with an acuracy of ±0°5'.

MS-3-25 SNAP GAGES

When you finish this learning package, you will be able to use snap gages to measure lengths, diameters, and thicknesses of parts.

MS-3-26 GEAR TOOTH VERNIER CALIPER

When you finish this learning package, you will be able to use a gear tooth vernier caliper to measure the addendum and the chordal thickness of any gear tooth.

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MACHINE SHOP - UNIT 4 - LAYOUT

MS-4-1 INTRODUCTION TO LAYOUT TOOLS AND ACCESSORIES

When you finish this learning package, you will be able to identify basic layout tools and answer questions about their use.

MS-4-2 USING LAYOUT TOOLS: PART 1

When you finish this learning package, you will be able to layout fluid, scriber, dividers, trammels, hermaphrodite calipers, and prick punch to do layout work to specifications.

MS-4-3 USING LAYOUT TOOLS: PART 2

When you finish this learning package, you will be able to use the vernier height gage, magnifying glass, angle plate, toolmaker's square, c-clamps, parallel clamps, 1-2-3 step blocks, precision square, gage blocks, and sine bar to do layout work to specifications.

MS-4-4 USING LAYOUT TOOLS: PART 3

When you finish this learning package, you will be able to use the combination set, vernier protractor, and protractor depth gage to do inspection and layout work to specifications.

MS-4-5 USING LAYOUT TOOLS: PART 5

When you finish this learning package, you will be able to use the surface gage, dial indicator, planer gage, center punch, and hammer to do layout work to specifications.

MS-4-6 LAYING OUT A T-SLOT CLEANER

When you finish this learning package, you will be able to layout a T-slot cleaner to specifications.

MS-4-7 LAYING OUT A DRILL AND TAP BLOCK

When you finish this learning package, you will be able to lay out a series of six holes on a drill and tap block.

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MACHINE SHOP - UNIT 5 - BENCH WORK

MS-5-1 INTRODUCTION TO BENCH TOOLS
When you finish this learning package, you will be able to identify basic bench tools.

MS-5-2 THE BENCH VISE
When you finish this learning package, you will be able to name the parts of a bench vise and do clamping operations on the vise according to specifications.

MS-5-3 FILES AND FILING
When you finish this learning package, you will be able to identify basic files used in machining and file work pieces accurately to specifications.

MS-5-4 HAND HACK SAWS
When you finish this learning package, you will be able to identify and properly use hand hack saws to cut metals.

MS-5-5 TAPS AND DIES
When you finish this learning package, you will be able to identify and properly use taps and dies to cut threads on work pieces to specifications.

MS-5-6 HAND REAMING
When you finish this learning package, you will be able to use hand reamers properly to ream holes in metals to specified sizes.

MS-5-7 HAMMERS, SCREW DRIVERS, CHISELS, PLIERS, AND WRENCHES
When you finish this learning package, you will be able to identify and properly use hammers, screw drivers, chisels, pliers, and wrenches.

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MACHINE SHOP - UNIT 6 - BENCH AND PEDESTAL GRINDING

MS-6-1 GRINDING WHEELS

When you finish this learing package, you will be able to use reference charts to select proper grinding wheels. You will be able to install the wheels on a grinder, adjust the wheels, and adjust the tool rest.

MS-6-2 DRESSING WHEELS

When you finish this learning package, you will be able to true and dress a grinding wheel for normal grinding operations.

MS-6-3 GRINDING A RADIUS

When youbfinish this learning package, you will be able to grind a $\frac{1}{4}$" radius to fit a $\frac{1}{4}$" gage.

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MACHINE SHOP - UNIT 7 - DRILL PRESS

MS-7-1 INTRODUCTION TO DRILL PRESS

When you finish this learning package, you will be able to name each control on a upright drill press and tell what each control does.

MS-7-2 SETUPS FOR DRILLING

When you finish this learning package, you will be able to use the proper holing devices to set up for the following drilling tasks: round stock, flat stock, sheet metal, irregular shapes.

MS-7-3 DRILL PRESS CUTTING TOOLS

When you finish this learning package, you will be able to identify cutting tools used in a drill press and tell what each one does.

MS-7-4 ADAPTERS AND SLEEVES

When you finish this learning package, you will be able to use sleeves and/or chucks to change the holding capacity of a drill press spindle.

MS-7-5 DRILLING HOLES

When you finish this learning package, you will be able to choose correct feeds and speeds for drilling holes in steel and aluminum. Accuracy will be ± 1/32".

MS-7-6 DEPTH DRILLING

When you finish this learning package, you will be able to use the drill press depth stops to drill holes to a specified depth, with an accuracy of ± 1/16".

MS-7-7 COUNTERBORING, COUNTERSINKING, AND SPOT FACING

When you finish this learning package, you will be able to use the proper tool to counter sink, counterbore, and spot face drilled holes to a tolerance of ± 1/32".

MS-7-8 ANGULAR HOLES

When you finish this learning package, you will be able to make table adjustments and use proper holding devices to drill angular holes in metal, to an accuracy of ± 1/32".

MS-7-9 RADIAL DRILL PRESS

When you finish this package, you will be able to answer questions about the parts and controls of a radial drill press and tell what each does.

MS-7-10 REAMING

When you finish this learning package, you will be able to use a straight or taper shank reamer to ream holes to a specified size, with an accuracy of ± 1/64".

MS-7-11 MACHINE TAPPING

When you finish this learning package, you will be able to use the proper tap drill size, tap, and tapping attachment to drill tap holes as shown on drawings, with an accuracy of ± 1/32".

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MS-7-12 PARTS OF A TWIST DRILL
When you finish this learning package, you will be able to name the parts of a twist drill and tell the purpose of each.

MS-7-13 TWIST DRILL SIZES
When you finish this learning package, you will be able to use charts and drill gages to select the proper size drill for a given application.

MS-7-14 TRANSFERRING HOLES
When you finish this learning package, you will be able to transfer holes from one piece of work to another by spotting with a twist drill, using a transfer punch, and using transfer screws.

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MACHINE SHOP - UNIT 8 - DRILL GRINDING

MS-8-1 FREEHAND DRILL SHARPENING

When you finish this learning package, you will be able to use the bench or pedestal grinder to sharpen a dull twist drill. Using a drill bit gage as a guide, you will be able to: keep the point angle to within ± ½° and keep the point centered to within ± 1/64" drill lip length.

MS-8-2 MACHINE DRILL SHARPENING

When you finish this learning package, you will be able to set up and operate a machine drill grinder to sharpen a two-lip twist drill and a three or four-lip core drill.

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MACHINE SHOP - UNIT 9 - POWER SAWS

MS-9-1 POWER SAWS: PARTS AND CONTROLS

When you finish this learning package, you will be able to name the main parts and controls of the horizontal band saw, the vertical band saw, and the power hack saw.

MS-9-2 CHOOSING POWER SAW BLADES

When you finish this learning package, you eill be able to choose the correct power saw blade for a given application.

MS-9-3 FREQUENT SAWING PROBLEMS

When you finish this learning package, you will be able to answer questions about diagnosing and correcting problems often met when using the power hacksaw, vertical band saw, and horizontal band saw.

MS-9-4 SETTING BLADE SPEEDS

When you finish this learning package, you will be able to use charts or a job dial selector to choose the proper speed of a band saw blade for a given job.

MS-9-5 SETTING UP POWER SAW CONTROLS

When you finish this learning package, you will be able to set up the operational controls of a power hack saw and a power band saw for a sawing operation.

MS-9-6 MOUNTING BAND SAW BLADES AND CUTTING STOCK

When you finish this learning package, you will be able to select, mount guides, and install blades on the vertical band saw, and cut stock with a vertical band saw to an accuracy of ± 1/16".

MS-9-7 WELDING BAND SAW BLADES

When you finish this learning package, you will be able to use the bulk blade provided and the welding attachment on the vertical band saw to weld band saw blades. You will weld blades to specified lengths for particular saws and to the thickness required by the blade thickness gage on the vertical band saw.

MS-9-8 VERTICAL BAND SAW: CUTTING CIRCLES, CONTOURS, AND STRAIGHT LINES

When you finish this learning package, you will be able to use the vertical band saw to cut contours, circles, and straight lines with an accuracy of ± 1/16".

MS-9-9 FRICTION SAWING

When you finish this learning package, you will be able to set up a vertical band saw for friction sawing of thins sheet metal.

MS-9-10 BAND FILING

When you finish this learning package, you will be able to select and set up a band file for a band filing job.

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MACHINE SHOP - UNIT 9 CONTINUED - POWER SAWS

MS-9-11 HORIZONTAL BAND SAW: STRAIGHT AND ANGLE CUTS

When you finish this learning package, you will be able to use the horizontal band saw to cut stock, with an accuracy of ± 1/16" and to make angular cuts with an accuracy of ± 1°.

MS-9-12 FINISHING A T-SLOT CLEANER

When you finish this learning package, you will be able to finish a T-slot cleaner to blueprint specifications.

MS-9-13 FINISHING A DRILL AND TAP BLOCK

When you finish this learning package, you will be able to finish a drill and tap block to blueprint specifications.

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MACHINE SHOP - UNIT 10 - ENGINE LATHE

MS-10-1 LATHE PARTS AND CONTROLS
When you finish this learning package, you will be able to point out the main parts and controls of an engine lathe.

MS-10-2 CUTTING SPEEDS AND FEEDS
When you finish this learning package, you will be able to choose proper feeds and speeds used to machine different kinds of metals on the lathe.

MS-10-3 INSTALLING CHUCKS
When you finish this learning package, you will be able to install all of the chucks used on a lathe.

MS-10-4 TOOL BIT GRINDING
When you finish this learning package, you will be able to: identify and sketch basic lathe tools, grind a general purpose tool bit for use on the engine lather.

MS-10-5 FOUR-JAW CHUCK TRUING
When you finish this learning package, you will be able to true a piece of rouns stock in a 4-jaw chuch.

MS-10-6 FACING TO LENGTH
When you finish this learning package, you will be able to machine a workpiece to a given length using a facing tool on an engine lathr with an accuracy of ±.001".

MS-10-7 COLLET ASSEMBLY AND CENTER DRILLING
When you have finished this learning package, you will be able to: set up a collet assembly on a lather, center drill a workpiece on the lathe.

MS-10-8 GRADUATED MICROMETER COLLAR: ROUGH AND FINISH TURNING
When you finish this learning package, you will be able to use a graduated micrometer collar to turn a workpiece to a specified diameter, with an accuracy of ± .001".

MS-10-9 NECKING
When you finish this learning package, you will be able to do a necking operation on an engine lathe.

MS-10-10 MOUNTING WORK BETWEEN CENTERS
When you finish this learning package, you will be able to mount a workpiece between centers properly.

MS-10-11 ALIGNING THE TAILSTOCK
When you finish this learning package, you will be able to adjust the lathe tailstock properle for turning a work between centers with an accuracy of ± .001".

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MACHINE SHOP - UNIT 10 CONTINUED - ENGINE LATHE

MS-10-12 DRILLING AND REAMING ON THE LATHE
When you finish this learning package, you will be able to drill and ream a workpiece on an engine lathe to a specified size.

MS-10-13 TURNING WORK ON A MANDREL
When you finish this learning package, you will be able to use a mandrel to turn a workpiece to a specified diameter.

MS-10-14 TURNING TO SQUARE AND FILLETED SHOULDERS
When you finish this learning package, you will be able to cut a square and a filleted shoulder properly.

MS-10-15 FILING AND POLISHING
When you finish this package, you will be able to file and polish a work piece on a lathe to a specified size.

MS-10-16 KNURLING
When you finish this learning package, you will be able to knurl a workpiece on a lathe.

MS-10-17 TAPER TURNING WITH A COMPOUND REST
When you finish this learning package, you will be able to turn a taper on a workpiece using the compound rest.

MS-10-17A CALCULATING TAPERS
When you finish this learning package, you will be able to: calculate proper compound rest angle settings for turning tapers using formulas and trigonometric tables and calculate taper per foot and taper per inch using formulas.

MS-10-18 TAPER TURNING AND TAPER ATTACHMENT
When you finish this learning package, you will be able to turn a taper using the taper attachment for the lathe.

MS-10-19 TAPER TURNING WITH OFFSET TAILSTOCK
When you finish this learning package, you will be able to cut a taper using the offset tailstock method.

MS-10-20 EXTERNAL THREADING WITH THREADING DIE AND HOLDER
When you finish this learning package, you will be able to use the engine lathe to cut threads on a workpiece with a threading die and holder.

MS-10-21 TURNING ON THE LATHE
When you finish this learning package, you will be able to cut an internal thread with the lathe by using a tap and holder.

MS-10-22 THREADING ON THE LATHE: EXTERNAL THREAD CHASING
When you finish this learning package, you will be able to: cut threads on a workpiece by using the lathe thread cutting mechanisms and chase external threads using a lathe.

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MS-10-23 BORING BAR

When you finish this learning package, you will be able to bore a hole to size on a lathe.

MS-10-24 INTERNAL THREADING

When you finish this learning package, you will be able to cut internal threads using the thread chasing mechanism.

MS-10-25 STEADY REST

When you finish this learning package, you will be able to set up and machine a long workpiece using a steady rest.

MS-10-26 FOLLOW REST

When you finish this learning package, you will be able to set up and machine a workpiece using the follow rest.

MS-10-27 FORM TURNING

When you finish this learning package, you will be able to turn a radius on the lathe by hand.

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MACHINE SHOP - UNIT 11 - MILLING : INTRODUCTION

MS-11-1 KINDS OF MILLING MACHINES

When you finish this learning package, you will be able to point out and name six different kinds of milling machines and briefly describe their uses.

MS-11-2 LUBRICATION AND PREVENTINE MAINTENANCE

When you finish this learning package, you will be able to lubricate and perform preventive maintenance on milling machines.

MS-11-3 SPEEDS AND FEEDS

When you finish this learning package, you will be able to figure speeds and feeds on a milling machine for given cutters and work materials.

MS-11-4 CUTTING FLUIDS AND OILS

When you finish this learning package, you will be able to identify, mix, and apply cutting fluids and oils in milling machine operations.

MS-11-5 ACCESSORIES AND ATTACHMENTS

When you finish this learning package, you will be able to point out and name several milling machine attachments and tell what is used for.

MS-11-6 INDEXING HEADS AND DIRECT INDEXING

When you finish this learning package, you will be able to: point out and name the five basic parts of an indexing head, describe the use of each part, and set an indexing head up for direct indexing.

MS-11-7 SIMPLE INDEXING

When you finsh this learning package, you will be able to change an index plate and set up an indexing head for simple indexing.

MS-11-8 ANGULAR INDEXING

When you finish this learning package, you will be able to: set up an indexing head for angular indexing and use the proper formulas to figure angular indexing settings.

MS-11-9 PREPARING THE HEAD FOR INDEXING

When you finish this learning package, you will be able to prepare an indexing head along with the footstock (tailstock).

MS-11-10 INDEXING: ALIGNMENT OF CENTERS

When you finish this learning package, you will be able to align the centers of an indexing head and tailstock with an aligning bar and dial indicator.

MS-11-11 VISE AND TABLE ALIGNMENT

When you finish this learning package, you will be able to: align a milling machine vise with a square, a dial indicator, and the marks on the vise base and align the table of a milling machine with the column face.

MS-11-12 ROTARY TABLE AND SLOTTING ATTACHMENT

When you finish this learning package, you will be able to identify and briefly describe the uses of the rotary table and slotting attachment.

MACHINE SHOP - UNIT 12 - MILLING MACHINES: VERTICAL AND HORIZONTAL
SECTION A - VERTICAL MILLING MACHINES

MS-12A-1 SOUTH BEND RAM TURRET: PARTS AND CONTROLS

When you finish this learning package, you will be able to name the parts and controls of a South Bend Ram Turret vertical milling machine and describe what each control does.

MS-12A-2 CINCINNATI NO. 3: PARTS AND CONTROLS

When you finish this learning package, you will be able to point out and name the parts and controls of the Cincinnati No. 3 vertical milling machine and describe what each control does.

MS-12A-3 MODEL "J" BRIDGEPORT: PARTS AND CONTROLS

When you finish this learning package, you will be able to point out and name the parts and controls of the Model "J" Bridgeport vertical head milling machine and describe what each control does.

MS-12A-4 MODEL "J" BRIDGEPORT: VERTICAL HEAD ALIGNMENT"

When you finish this learning package, you will be able to align the head of a Model "J" Bridgeport vertical head milling machine.

MS-12A-5 MODEL "2J" BRIDGEPORT: PARTS AND CONTROLS

When you finish this learning package, you will be able to point out and name the parts and controls of the Model "2J" Bridgeport vertical head milling machine and describe what each control does.

MS-12A-6 CINCINNATI MODEL "D" TOOLMASTER: PARTS AND CONTROLS

When you finish this learning package, you will be able to point out and name the parts and controls of the Cincinnati Model "D" Toolmaster vertical milling machine and describe what each control does.

MS-12A-7 VAN NORMAN MODEL 13: PARTS AND CONTROLS

When you finish this learning package, you will be able to point out and name the parts and controls of the Van Norman Model 13 milling machine and describe what each control does.

MS-12A-8 VERTICAL MILLING MACHINE CUTTERS

When you finish this learning package, you will be able to point out and name cutters used in vertical milling operations and describe their uses.

MS-12A-9 MOUNTING CUTTERS AND CUTTING A KEYSEAT

When you finish this learning package, you will be able to mount vertical milling machine cutters properly and cut a keyseat, using a 4-flute end mill.

MS-12A-10 VERTICAL MILLING SETUPS AND OPERATIONS

When you finish this learning package, you will be able to identify and make setups on a vertical milling machine.

MACHINE SHOP - UNIT 12 - MILLING MACHINES: VERTICAL AND HORIZONTAL
SECTION B - HORIZONTAL MILLING MACHINES

MS-12B-1 CINCINNATI UNIVERSAL NO. 2: PARTS AND CONTROLS
When you finish this learning package, you will be able to name and point out the parts and controls on the above milling machine and describe what each control does.

MS-12B-2 HORIZONTAL MILLING MACHINE CUTTERS
When you finish this learning package, you will be able to point out and name cutters used in horizontal milling operations and describe their uses.

MS-12B-3 MOUNTING HORIZONTAL MILLING CUTTERS
When you finish this learning package, you will be able to mount horizontal milling machine cutters properly.

MS-12B-4 HORIZONTAL MILLING SETUPS AND OPERATIONS
When you finish this learning package, you will be able to identify and make setups on a horizontal milling machine.

MS-12B-5 INSTALLING A VERTICAL HEAD ATTACHMENT
When you finish this learning package, you will be able to install, lubricate, and operate a vertical head milling attachment.

MS-12B-6 CUTTING A SPUR GEAR
When you finish this learning package, you will be able to set up a horizontal column and knee type milling machine for cutting a spur gear and cut a spur gear according to blueprint specifications.

MS-12B-7 CUTTING A RACK GEAR
When you finish this learning package, you will be able to set up a horizontal column and knee type milling machine for cutting a rack rear and cut a rack gear according to blueprint specifications.

MS-12B-8 CUTTING A HELICAL GEAR
When you finish this learning package, you will be able to set up a horizontal column and knee type milling machine for cutting a helical gear and cut a helical gear according to blueprint specifications.

MACHINE SHOP - UNIT 13 - SHAPER

MS-13-1 SHAPER: PARTS AND LUBRICATION

When you finish with this learning package, you will be able to name the main parts of a shaper and lubricate a shaper to manufacturer's specifications.

MS-13-2 SHAPER CONTROLS

When you finish this learning package, you will be able to name the operating controls of the shaper and tell what each does.

MS-13-3 CUTTING TOOLS

When you finish this learning package, you will be able to name common cutting tools used on the shaper and describe and tell the purpose of the angles ground on each tool.

MS-13-4 VISE ALIGNMENT: SHAPER SAFETY

When you finish this learning package, you will be able to: level and align a shaper vise using a dial indicator and a precision square or parallel, and state important safety rules about the shaper swivel head and vertical tool head.

MS-13-5 MACHINING A FLAT, HORIZONTAL SURFACE

When you finish this learning package, you will be able to set up and machine a flat, horizontal surface on a shaper.

MS-13-6 SETUPS FOR VERTICAL AND ANGULAR CUTS

When you finish this learning package, you will be able to set up a shaper and machine vertical and angular cuts on a workpiece to given specifications.

MS-13-7 FEEDS AND SPEEDS

When you finish this learning package, you will be able to figure proper feeds and speeds for different shaper operations, using formulas and charts and set a shaper for a given cutting speed, number of strokes per minute, and feed per stroke.

MACHINE SHOP - UNIT 14 - SURFACE GRINDING

MS-14-1 SURFACE GRINDER PARTS AND CONTROLS

When you finish this learning package, you will be able to name the main parts and controls of a surface grinder.

MS-14-2 SELECTING AND CHANGING GRINDING WHEELS

When you finish this learning package, you will be able to select and change grinding wheels on a surface grinder to meet requirements of the material to be ground.

MS-14-3 MOUNTING AND DRESSING GRINDING WHEELS

When you finish this learning package, you will be able to select, test, mount, and dress the proper grinding wheel for a given job by using the diamond tip dresser to true the wheel in relation to the magnetic chuck.

MS-14-4 MAGNETIC CHUCKS

When you finish this learning package, you will be able to position and secure a workpiece on the magnetic chuck of the surface grinder and align the workpiece surface so that it is parallel to the face of the grinding wheel, using a dial indicator to get an accuracy of ±.001".

MS-14-5 GRINDING A WORKPIECE

When you finish this learning package, you will be able to make a finish drawing and grind two parallel bars to the specifications of that drawing with an accuracy of ±.0005".

MS-14-6 WHEEL DRESSING: CONVEX OR CONCAVE RADIUS

When you finish this learning package, you will be able to set up a radius dresser and dress a grinding wheel to a convex or concave radius.

MACHINE SHOP - UNIT 15 - TOOL POST GRINDING

MS-15-1 SETTING UP A TOOL POST GRINDER

When you finish this learning package, you will be able to set up a lathe and tool post grinder for a grinding operation.

MS-15-2 EXTERNAL TOOL POST GRINDING

When you finish this learning package, you will be able to grind a lather center point properly to fit a center gage in 55 minutes.

MS-15-3 REAMER SHARPENING ON THE TOOL POST GRINDER

When you finish this learning package, you will be able to sharpen a machine reamer properly on a tool post grinder in 1½ hours.

MS-15-4 INTERNAL TOOL POST GRINDING

When you finish this learning package, you will be able to grind a drill bushing bore to blueprint specifications with a tool post grinder in one hour and twenty minutes.

SUGGESTED CRITERIA
SELECTION OF SCHOLARSHIP STUDENT
TO
GREENVILLE TECHNICAL COLLEGE
MACHINE TECHNOLOGY PROGRAM

There is agreement among the three secondary machine shop instructors that some following criteria should be applied to selecting the "most outstanding or worthy student" from the secondary Machine Shop program to be awarded a scholarship to the Machine Technology Program.

There, however, is a greater need at present to encourage secondary machine shop graduates to continue their vocational education at the post-secondary technical college level. Some of the reasons that students given for not accepting a scholarship or continuing their training include; not being able to afford the minimum costs of books or travel that accompany scholarships, the desire for immediate employment and earning, etc.

APPENDIX H

INSTRUCTIONS FOR ANSWERING OUTCOME-REFERENCED TEST ITEMS

Typically, eleven (11) different types of outcome-referenced test items may be used in the competency test.

1. True-False
2. Completion (Fill-in Blanks)
3. A Combination of True-False and Completion
4. Multiple-Choice
5. Matching
6. Identification
7. Short Answer
8. Long Answer
9. Program Product of Performance Test
10. Simulated Performance Test
11. Actual Performance Test

An example of each type of test item is included. Carefully study the illustration test item and the directions for answering the question. These directions will not be given again. Your test questions may vary slightly in the format, however, the instruction should be applicable. Where necessary, the instructor will supplement these instructions for answering outcome-referenced test items.

Do not guess. Guessing does not add to your knowledge, even if you happen to guess right. If you do not know the answer skip the test item and go to the next question. Remember: Enter your answers in the blanks provided on the separate answer sheet, if used.

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1. TRUE-FALSE

Directions: Read the statement carefully. Decide whether it is true or false. Answer by marking T or F in the blank provided to the right (or, if answer sheet requires, mark "X" in the appropriate (T) or (F) parenthesis, or "circle" T or F).

Example: Lumber shrinks across the grain of the board. (T) (F)

2. COMPLETION (Fill-in Blanks)

Directions: Complete the statement by printing on the blank line the word or words which make a complete and correct statement.

Example: Proper edge spacing will restrict __?__ and ensure good weld penetration. distortion

3. COMBINATION OF TRUE-FALSE/COMPLETION

Directions: If the statement is correct, in the parenthesis mark (T) or answer true, as required. If the statement is incorrect, mark (F) in the parenthesis and fill in the blank provided with the appropriate word or term which, if substituted for the underlined word, would make the statement correct.

Example: A pantry chef usually is the head chef's first assistant. (T) (F)

sous

4. MULTIPLE-CHOICE

a. Directions: You are given three or four choices from which to make a complete and correct statement. In the blank answer space provided, write in the "letter" indicate the best choice.

Example: The head chef's first assistant is a __?__.

a. junior chef
b. sous chef
c. pantry cook

b

b. Negative Answer Multiple-Choice

Directions: If the multiple-choice question includes the word EXCEPT, you should look for the choice that does not fit the question. Read the entire question carefully before you choose your answer.

Example: All of these could cause high starter current draw EXCEPT:

a. work starter bushing
b. bad starter relay
c. grounded field coils
d. grounded armature

b

5. MATCHING:

Directions: For each given item in the left hand column, match it with the appropriate item from the right hand column. Write the letters of the correct or best answer in the appropriate blanks.

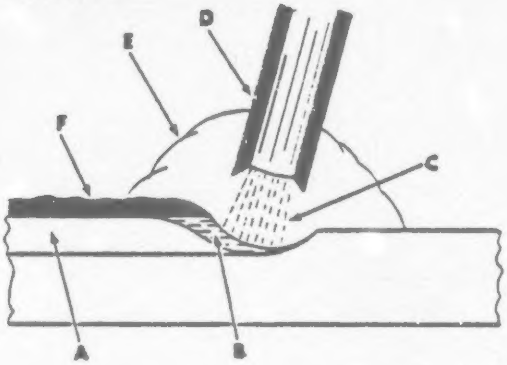
Example: Match these metric terms on the left with their proper equivalents.

b	deca	a.	thousands
c	meter	b.	tens
a	kilo	c.	units of length measurement

6. IDENTIFICATION

Directions: Identify each labeled part of the illustration below and write the name next to the appropriate letter in the blank provided.

Example:



a. base metal
b. molten metal
c. arc
d. electrode
e. gas shield
f. slag

7. SHORT ANSWER

Directions: Write the correct answer in the blank provided.

Example: What type of electrode is best for vertical and overhead welding? fast-freeze

8. LONG ANSWER

Directions: Using as few words as possible, write the answer to the question in the blank provided.

Example: What should be done if the electrode welds fast to the work?

"Electrode should be broken loose by twisting or bending the holder."

9. PROGRAM PRODUCT OR PERFORMANCE TEST

Definition: Concrete project or production accomplishments during training are used to test knowledge or skill. Typically, test pressures are missing and the student may have had help in completing the task.

Directions: Instructor will observe student during training and by checklist or rating scale will rate student's performance or knowledge.

Example: Given an oven for baking, food items, and necessary implements and equipment; load the oven with foods to be baked. All items on a checklist used to rate performance must receive an acceptable rating. The task must be accomplished within 15 minutes.

CHECKLIST

(Load Oven Racks)

ACTIVITY	RATING	
	Acceptable	Unacceptable
1. Gathered needed supplies.		
2. Used needed supplies.		
3. Pulled oven rack partially out while loading.		
4. Stacked oven shelves 8 inches apart for baking.		
5. Placed food on rack so that heat circulated adequately.		
6. Followed appropriate safety precautions.		

10. SIMULATED PERFORMANCE

Definition: Contrived situation, resembling tasks the graduate will be required to do on the job. This form of test is useful for evaluating transferable skills such as reasoning, attitudes, and psychomotor skills necessary for occupational success.

11. ACTUAL PERFORMANCE TEST

Definition: Exhibits the advantage of realism, but may be too late to help either the student or the vocational program correct failures.

Example: Given an automobile with a leaking pinion seal, access to proper tools and equipment, replacement parts, and service manual; replace the pinion seal according to manufacturer's recommended procedures. The job should be completed within 2 hours. The manufacturer's specifications must be met and the completed job must meet the instructor's standards.

ANALYSIS OF SECONDARY INSTRUCTIONAL TIMES

Instructional times and tasks have been described based on a State of South Carolina requirement that 3-hour blocks of training total 540 hours per year or 1,080 hours for two year programs.

Currently vocational programs in career centers typically are conducted on the 3-hour block time frame. Most vocational programs currently are offered for a two year period. Some vocational courses, such as office occupations areas, may be offered for only one or two hours of training daily.

While the "suggested instruction times" for the tasks in this guide have been allocated based on a 3-hour vocational instruction day, many vocational students in reality are not in the classroom for a full three hours. Students, typically, must be bused to and from feeder high schools with transit times typically of about 15-30 minutes per trip one way. In addition, students typically are given at least one break during instruction and some instructional time is lost as students change clothes for shop work and then change back into regular school clothing. Add to this lost time the possible time lost to feeder high school activities such as 'pep ralleys' and other activities and the resulting vocational instructional day probably is less than 1.5 to 2 hours per day of actual instruction or training.

Realistically, a total instruction time of from 270 to 360 hours of vocational training probably is more accurate for a 3-hour block program in one year than 540 hours.

It is important to recognize this potential situation as vocational instruction is planned and evaluated.

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APPENDIX K

BINDER DESIGN

(Occupational Education Articulation Program)

The binder design is simple and straightforward.

Two triangular figures, in balance, represent the two institutions participating in articulation.

Two levels of training are represented by the placement of the triangular figures and the identification of the two institutions.

Horizonal and vertical lines represent lateral and vertical articulation.

The diagonal across the design represents the progressive movement in career development for successful job performance.

The two figures are not closed when they face, but allow for interaction and are linked by the document title: Articulated, Performance-based Instruction Guide.